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To ensure that the *Journal* meets the needs of its customers and retains its high reputation, the Board of Editors is reviewing its policies, particularly regarding the content and style of the *Journal* and its *Supplement*. We would, therefore, welcome any comments, to the address shown below, and will be seeking specific feedback from a sample of our customers during the next few months.

Deputy Managing Editor
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EDITORIAL

The role of telecommunications in global communications is almost taken for granted. We expect to see news from around the world as it happens. We followed the news from Tiananmen Square earlier this year, and more recently the evolving situation in Eastern Europe, and can imagine the flood of data flowing between New York, Tokyo, Hong Kong and London during major Stock Market fluctuations. Telecommunications is increasingly a global business.

In his Keynote Address in September 1989 to the London Centre of the Institution of British Telecommunications Engineers, David Dey, Managing Director, British Telecom Communications Systems Division, reviewed the nature of the international market, emphasised the need for us to understand and respond to customer needs, and outlined BT's future plans. As the year 2000 approaches, telecommunications will have to respond to the economic, social and demographic changes taking place around the world. Jon Chidley, General Manager, Strategic Market Development Unit, develops this theme, identifying the home as a multi-activity centre for all members of the family requiring telecommunications services for social and business needs.

In the UK, the modernisation of the network is rapidly progressing with digital switching and transmission technology, optical-fibre systems, network management, etc. The characteristics of the emerging network will demand radical changes in approach. If we are to use it to the best advantage to our customers and shareholders, then an integrated network administration programme is essential. The implementation programme is outlined in the article by Alan Bealby, General Manager, Network Operations Support.

Other articles in this wide-ranging issue of the *Journal* underline the global nature of BT's business, and illustrate the professional approaches required to ensure high-quality products and services.

British Telecom—The Multinational Company

Keynote Address to the Institution of British Telecommunications Engineers

D. DEY†

This article is based on the Keynote Address given by David Dey, Managing Director, British Telecom Communications Systems Division, to the London Centre of the Institution of British Telecommunications Engineers on 29 September 1989. He considers the pressures of competition on BT and the need for BT to develop its business internationally.

INTRODUCTION

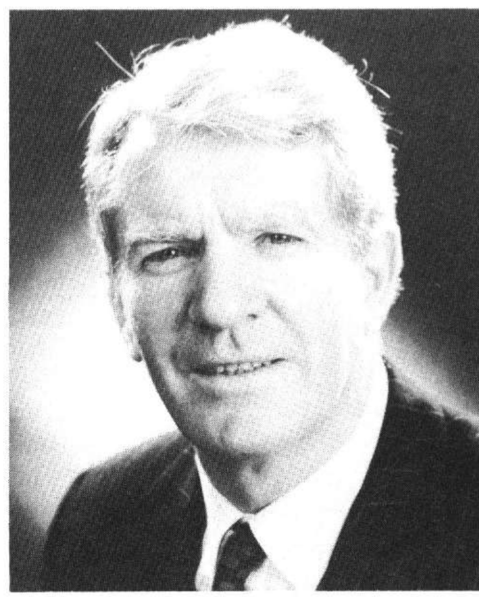
During the past decade, managers in businesses as diverse as semiconductors, automobiles, copiers, television sets, machine tools, foundries, telecommunications and financial services have had to accept a new reality and that is of global competitors and global competition.

Coinciding with that awakening has been a realisation that developing and implementing global strategies requires much more than a good analysis of the costs and the technology, and a great deal more than writing papers for boards and committees.

The ability to compete in the global marketplace requires not only the skill to foresee the shifting patterns of competitors and market requirements, but in equal measure the ability to redeploy resources to maintain, and in some cases regain, competitive advantage. It also requires the ability to motivate people at different levels in the business and to keep them alert and focused on competition. Although much progress has been made, the business has still a long way to go in terms of focusing on and understanding competition. Therefore, the overall tasks of senior management are analysis and identification of competitive problems, opportunities, threats; redeployment of corporate resources and motivating the entire team to develop the business. Those are very general and generic activities in multinational companies.

PRESSURES ON BT

We are driven by some additional pressures. Our large UK customers are going multinational. More and more, people are moving away from the theme of the 1960s and the 1970s which was very much to diversify and become a conglomerate. People are realising that there are very few managers who have the competence to run conglomerates successfully, and compete in many different businesses at the same time.



David Dey, Managing Director, British Telecom Communications Systems Division

Most of our large UK customers in manufacturing, banking or retail have been going overseas and with that they have been saying to our National Account Managers, 'We want to expand our network. We want one-stop shopping where you will take responsibility for our network world-wide and will bill and service that network centrally'. Therefore, recognising the needs of its most important UK customers in the business side, we have to expand our capabilities beyond the national boundaries.

In addition, we have had very aggressive competition from other UK operators. Mercury, has won significant amounts of business, particularly from large customers closest to its network. This is something that we must compete with very aggressively. In addition, Racal Telecommunications has become a very effective competitor, not only in terms of Vodaphone, but also in winning and building the government data network. So, in the UK, there is significant UK competition being encouraged by the Government.

† Managing Director, British Telecom Communications Systems Division

Furthermore, a pattern that has been seen over the past 20 years is where companies in high-technology industries, particularly Japanese and US companies, have used the United Kingdom as a launching pad for their move into Europe. This is happening now in telecommunications. Large communications companies such as AT&T and the RBOCs (Regional Bell Operating Companies) are taking up positions in the UK. Clearly, we have to recognise this, and compete in a normal commercial and ethical way.

MEETING THE PRESSURES

Therefore, we are under great pressure in the UK from outside and inside competitors. A simple option would be to adopt a fortress-BT-in-the-UK mentality, and say life is too difficult going abroad, let us stay where we are, consolidate our position in the UK, and run a very successful telecommunications business in the UK. It would be very successful, but it would be a diminishing business. Belonging to a company that is getting smaller is a depressing business; the opportunities for developing and broadening one's career diminish quite quickly. In principle, the management team setting the direction for the company is determined that BT will be a growing company. We do not want to have a fortress in the UK. Therefore, we have to respond to the requirements of customers who want to have one-stop shopping for world-wide networks, and to respond and get ahead of the competition.

The management team's responsibility is to recognise the obligation that it has to its shareholders, employees and customers. We have to accept the reality, and resolve to protect the UK position; this can be done in a number of ways. It can be done through the quality of service; this has improved substantially over the past 18 months. We can protect our UK position on price. The other high-technology industries, because of ease of entry into those industries, reduce their prices at a rate of about 10%–15% a year, and have conditioned themselves to an environment where they need to reduce their prices by at least 10% a year. The way we can overcome the artificial constraints of the regulator, and increasing competition from companies, is to concentrate on increasing quality of service and reducing prices. There is no reason why BT should not become the low-cost supplier of high-quality communications systems and services, and I do mean high quality because low cost and high quality do go together. I am not referring to cheap products, but a business that delivers services and products with a minimum amount of waste. Through that we can maintain and improve our market share. If we take an ethical and a commercial approach to what we do, we can win the business. That is really how we came to the conclusion about the strategy, mission and goal for our company.

BT can become the most successful telecommunications company world-wide; in discussing that the expression 'a window of opportunity' comes to mind. When one looks around the industry world-wide, the European PTTs are still primarily national monopolies that have not gone through the pain and orientation of becoming aggressive commercial international companies. The RBOCs in the United States too are still very constrained; they have little or no international experience or international tradition. BT therefore has a big advantage over the RBOCs.

Two large companies that could make inroads into BT's business are AT&T and IBM. However, IBM has very publicly demonstrated that it does not intend to get into telecommunications, and the recent sale of ROLM to Siemens demonstrates that once again. AT&T, in the view of some people, may not be as flexible as it will have to be in order to compete world-wide. However, it will still be a very aggressive competitor, and could damage BT, but it will not be as successful as BT if we co-ordinate our efforts in addressing the market-place. In my opinion, AT&T's recent purchase of ISTEL was a major response to BT's purchase of Tymnet. It is important that BT is in a position where it has the lead and the initiative, in order to achieve the goal of being the world's most successful telecommunications group.

STRATEGY

There are four legs to that strategy of being the world's most successful telecommunications group. The first is access to, and control of, networks world-wide: voice networks, data networks, mobile networks, satellite networks, and personal communication networks. However, you do not sell networks, you sell products, applications and services.

The second leg of the strategy is having a coherent portfolio of BT products, in a BT house style, that can be integrated together and used easily by customers, and that are supported by the best possible family of network management systems which can be unique to BT. BT needs exclusive distribution of those products in the UK so that it is not competing with its suppliers in the market-place. BT also needs access to those same products world-wide because when large international companies come to BT requiring a world-wide network, they want a network that has the same product at each of the nodes. They do not want to have to train their own staff and modify their own systems in order to cope with a wide variety of different products.

The third leg of the strategy is the infrastructure, because to sell those products and to install them world-wide, people are needed on the ground. All the time, through organic growth and through acquisition, BT will have to build up a very substantial force of people in the key strategic territories—probably the 30 most developed countries in the world.

The fourth emerging part of the strategy is the one referred to earlier about being the low-cost supplier.

When considering our actions since developing this strategy, one will see that the investment in McCaw is consistent with that strategy. It gives BT access to the largest mobile network in the world. There are a lot of emerging synergies between McCaw and Mobile Communications in terms of product requirements, standards and marketing programmes. The investment in Tymnet, I believe, is much more important as a business because for the first time it gives BT a truly international network. Tymnet again supports the customer need. The customers are looking for a data network where they can have a direct data transmission to their factories, distributors, and customers around the world.

It must be emphasised, however, that we are not in the business of sitting with a large amount of money looking for opportunities. We turn down many opportunities for investing in companies because they do not fit in with the strategy. Instead, BT is looking for companies and partners where there is a sound strategic fit.

OVERSEAS GROWTH

What are the requirements in terms of trying to grow overseas? Firstly, access to the markets is required. In the application sense, markets where access is available in some countries to a limited degree are data and customer premises equipment, if one has the portfolio. In addition, mobile communications is beginning to be used by a number of countries as the first opportunity to get a little competition going with some reasonable degree of entry from new players. This is happening in Spain, Greece and Germany.

A great debate goes on about the value of a 20, 25 or 30% stake in another major telecommunications company. If it is a sound financial investment, if it is going to return profit and dividends to the company, and if there are commercial synergies in terms of engineering and development and transfer of workload between the networks, then owning a 30% stake in a business can make a great deal of sense. Without doubt, in the mid-1990s, a considerable amount of consolidation and shuffling of the players in the telecommunications industry will take place. Hopefully, four or five world-wide telecommunications operating companies will emerge. As that happens, BT must have a number of stakes in other companies so that the management team is in a position to build the BT world-wide telecommunications company. That may mean selling some things, trading some things and buying some things. Without this, BT could not win when that consolidation and reorganisation takes place. Liberalisation has been slow, but there are signs of it beginning to pick-up. Clearly, Germany is moving much more quickly than anyone anticipated. The UK is by far the most liberal country in the world. The US is quite liberal and Japan and Spain are opening up. So, country by country, opportunities are beginning for getting into customer premises equipment (CPE), mobile, data communications, and, in the not too distant future, voice.

But, one must have something to sell in the world market, and an important element is a CPE portfolio which is competitive in world markets, together with type approval for that portfolio in the countries that one is trying to penetrate. In the mobile area again, one must have products that meet the standards of that country, and hopefully more and more of those will be international standards.

I believe one of our unique opportunities is in software systems, not enormous software systems because, as a programmer, I question whether it is possible to move a 2 million line software system from one customer in one country to another customer who thinks he has the same requirements. (The customer's true requirements may mean that a substantial amount of the code has to be rewritten.) But, if BT develops network management systems in a very modular fashion, and in a very open fashion, I believe the company will have a leading edge.

Thus, in order to develop overseas business, it is necessary to have access to the markets, access to the countries, and saleable products. However, perhaps most importantly, people are also required who can work in a multinational environment. People are needed who can think multinational about customer requirements. BT must look beyond considering UK customer requirements only, and find a way of building the process that will consider requirements as seen by more than a UK customer. A way must be found to develop solutions for world markets. It is not going to be easy, because these solutions may then not be optimised to meet the precise requirements of BTUK.

We must have people who understand international distribution. What can be moved around? How best can it be moved around? What cannot be moved around? People are needed who can communicate internationally, and this does not mean just in terms of speaking different languages. For example, when you wish to ask an Italian, a Frenchman, a German and a Scot to do the same thing, different phrases must be used, very different English words and attitudes, and that takes a very long time to develop. People are needed who are willing to live and work abroad. However, only about 5% of the working population are willing, skilled and able to do this; BT must therefore develop more people who are in that category. BT needs to staff its international business and international companies with local nationals who have a

strong commitment to BT and the success of BT. This will take a long time to build. It will be done partly through organic growth, which BT has been doing. But that too is difficult, because to set up an operation for example in Spain, to open an office with five or six people there to start the selling process, which may not result in any revenue for 2 to 3 years, is probably going to cost about £1M a year. Some may feel that a £1M a year is not a lot for a company that makes a £1M profit an hour in a working day. But BT is not in the business of investing without a clear business case. It needs a clear marketing plan for what products are going to be launched and when. It also needs a commitment from the people who are launching the products that they would sell volume and make a profit. It will be a very tightly controlled organic process. In addition, there will be a very selective acquisition of companies that fit into BT's strategy that would give BT very dedicated Italian, Spanish, French and Americans, and BT is going to have to turn those into very dedicated BT people as quickly as possible.

CONCLUSION

I have no doubt that, by the year 2000, 30% of BT's revenue and profits will come from overseas operations. 30% of the people in BT will be non-British nationals, not located in the UK. BT will have well-established subsidiaries in 30 countries. It will have a world-wide voice, data and broadband network which it plans, builds, owns and operates. In addition, BT will have an international headquarters outside the UK. All of that is a great challenge, but I would like to look on it as an opportunity for all in British Telecom.

Biography

David Dey joined British Telecom in January 1988 after a distinguished career in IBM and Plessey. He joined IBM in 1960 and in the next 25 years held a number of senior management appointments in the UK, Europe and the USA. These included the position of Director of Marketing for IBM UK, Area General Manager for Africa and the Middle East, Vice President for Quality for IBM Europe and Group Director of Product Management for IBM Europe based in New York. In 1985, he joined Plesssey as Managing Director, Plessey Telecommunications Office Systems Ltd. He is now Managing Director of British Telecom's Communications Systems Division with responsibility for a world-wide portfolio of products, systems and applications, and territorial responsibility for British Telecom's activities in continental Europe and North America. He was appointed to the Board of British Telecom on 1 November 1988.

A Market View of the Network

J. CHIDLEY†

This article gives a marketing view of the services that a customer will require from BT's networks as they evolve. The customer can be an individual in a private or business role, an organisation offering a range of social or business services over the network, or a corporate customer building a communications capability for a company. For the majority of customers, the basic need remains a transparent trouble-free network; however, there are individuals and companies who are making an increasing use of communications. The article goes on to describe the types of services that network designers will have to consider to meet these emerging needs and poses key questions in numbering, billing, management, ease of use and personal control.

INTRODUCTION

This article gives a view of BT's networks as seen from the market-place and outlines key issues for their future development from some simple models of the market.

We start with a definition of a market as composed of 'Customers with a communications need and the willingness and ability to pay to have that need met'. This takes us on to asking: 'Who are our customers?'. At first sight this should be easy; we have records for most, if not all, business installations in the UK and the bills for each residential customer. However, we need to take a wider view.

For example, a company consists of at least two types of customer: the telecommunications manager responsible for running the communications infrastructure of the company, and individual managers using the telephone and other communication facilities as part of their work. Similarly, within the home, each family member has his or her own reasons for making use of the telephone, and this may vary depending on the social situation at the time. It may also be the same individual using the telephone at home and in the office, providing a link between the social and business environments.

For this article, we will make use of the very simple segmentation shown in Figure 1, into *corporate* and *individual* customers, and a growing number of *service providers* satisfying both types of customer.

THE INDIVIDUAL AS CUSTOMER

We begin with the individual as customer, taking first the private individual and then moving on to the business role. Conventionally, BT has taken the installation address and therefore the bill-payer as the residential customer. This is a constraining definition since the home telephone could be used for business purposes, and because several adults and children may use the telephone at that address. Individuals also make use of other telephones for social reasons, at work or while travelling. As we shall see, a location-based definition of a customer will become increasingly redundant.

A better definition for marketing is: 'The telephone user in her or his private capacity, using the telephone for personal purposes'. In its widest sense, this group includes the person making the call, the person receiving the call and the person paying for the call—a *social network*.

Social Networks

As we head for the year 2000, these social networks will be affected by demographic trends in social and household structure, some of which are illustrated in Table 1.

Many of these trends will result in wider social networks leading to more demand on existing services; for example, keeping in contact with an extended or widespread family, or occupying more leisure time.

It also places emphasis on those receiving calls, some of whom may have a low call bill, but who form an integral part of the social network. If we take the purpose of the telephone as allowing people to converse, then just making

† Strategic Market Development Unit, British Telecom

Figure 1
Simple customer segmentation

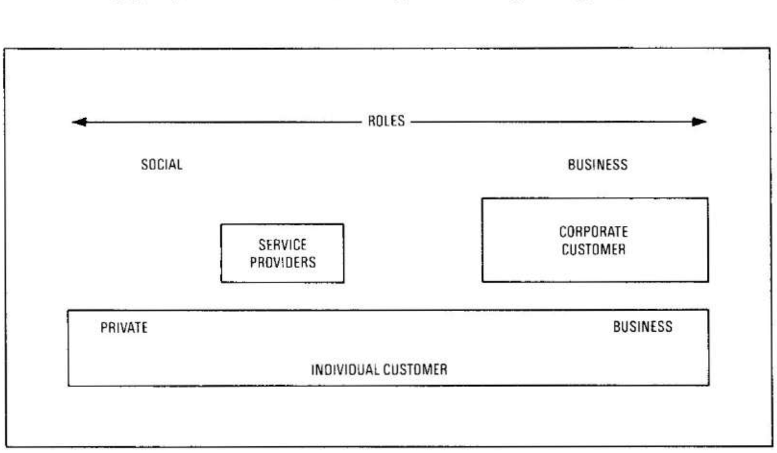


TABLE 1
Longer Term Demographic Trends

- More over-75s living at home
- More empty-nesters—couples without children
- More families with young children
- More co-habiting couples
- Fewer young singles
- One in three marriages ending in divorce
- Two million divorcees and rising
- One in three marriages involving remarriage for one or both partners
- One million one-parent families

Source: Henley Centre

the network connection will no longer be enough; if the receiver is out, then network voice services may need to be designed to 'take a message' and deliver it later on behalf of the caller.

So how do these customers view BT's networks? The simplest answer is that, for the majority of the time, the individual customer simply wants to pick up the telephone and talk, first time, to a particular person. How BT makes the connections is of no concern to them. The point at which awareness of BT's network creeps in is usually when something goes wrong.

The residential and business individuals require first of all an invisible network which is non-intrusive in terms of the quality of the connection, but when something does go wrong, it gets fixed quickly.

The Home as an Activity Centre

To go beyond this utility view of BT and to understand some of the emerging communication needs, we have to look deeper into some of the social trends induced by the steady growth in personal affluence and structural changes in households and patterns of employment. These factors are having a significant effect on lifestyles, with growing individualism and mobility, and rising expectations of consumer products and services, including the telephone.

The 'home of the future' is already taking shape. One trend was brought out in a recent survey in which 70% of those questioned expect family members in the future to become more independent. Half of those questioned also thought that families would spend less time together. This suggests that the designers of network services should be looking at and developing services tailored to individual members of the family.

Behaviour patterns in terms of home and work have changed relatively slowly; recent surveys, however, indicate a wide range of activities that individuals said they would engage in from their home, given the opportunity. Although the impact of home shopping in a range of consumer areas is still relatively small, nearly half of those surveyed said that, if they could, they would seek medical advice for minor ailments and conduct banking from home. Almost as many would be prepared to seek minor legal advice, while around a third would choose a holiday and shop for everyday essential household goods.

We also know that a small, but significant, percentage of all residential customers use their home telephone primarily for business calls. Add to this the increasing number of people who are working from home, either as remote workers for their company, or as a small business, then we will have a growing number of people requiring services to meet their business needs. So, much as today we have in many homes an entertainment centre of TV, video and stereo decks, we may in the future have a stacking communications centre containing fax, telephone and video links, all requiring network connections.

The home has become a multi-activity centre for all members of the family requiring services for social and business needs. The immediate issues for the network centre on providing a range of services tailored to individual members of the household and provided by BT or by third-party service providers. These will involve numbering to give a different identifier to each family member, and billing schemes which identify each user. Finally, there is the issue of control, to which we shall return, through which access or non-access to these services is managed.

The Individual in Business

We can take this theme of the individual further by following them from home to his or her place of work. For many *business individuals*, the voice, data and messaging facilities will be provided by the company, but there is still a wide choice of how each individual chooses to use those facilities. Many are provided by sophisticated features on a PBX or Centrex, but again the network on which they are delivered is transparent to the user; she or he only wants access to a range of services to do the job. Increasingly, companies will make more use of communications and the range of services open to the business individual will grow. For larger businesses, the infrastructure on which this will be based is the *corporate network* built from a combination of private and public network services. A later section will describe how this set of services is defined and what the *corporate user* will expect from the network.

The Individual at Large

Both of the situations described above deal with the individual in a fixed location, at home or in the office. Increasingly, the customer will want access to his or her range of business and private services when away from these bases, for example, access to the full range of business services at home, or access to both social and business services while travelling or staying away from both the home and office, and will

wish to be contacted wherever she or he happens to be.

We already have a range of *mobility* services: payphones, pagers, credit cards, mobile telephones and the emerging Telepoint services based on the convergence of fixed and mobile technologies. These form a kit of services for the customer enabling her or him to contact or be contacted, and have access to services at any time.

Today, these tend to be regarded as separate services, supported by separate networks. But with growing awareness and experience in their use, the customer will wish to simplify her or his life. The personal communicator with a single number (or two: one for social, one for business) which gives access to services at all times will be expected. How, and on what network, we deliver these services is again BT's concern. A theme of transparency again comes through, but, additionally, we now have the concept of independence of the user from a fixed base, raising issues of convergence of the fixed and mobile networks, in addition to numbering and location finding.

Reducing Complexity and Giving Control

We have now built up a picture of the emerging requirements on the networks to provide a set of services tailored to each person depending on the role they are playing at the time. As we have seen, this has implications for numbering and billing, but also raises questions of complexity and control.

Satisfying emotional as well as rational customer needs will be of increasing importance as individuals are faced with the complexity of more advanced technological solutions. This will have an impact on the take up of services; having to press buttons to generate MF4 signals may delay widespread use of a service, whereas voice recognition may be more acceptable. Simplifying the access to services must be a major factor in their design and introduction, and be incorporated both in equipment and as network embedded features.

But the customer will also want control in a different sense. The term *cellular fatigue* has already been coined to describe the situation of not being able to switch off the mobile telephone for intrusive business calls while at home or a social event, while keeping it on for social calls. A customer will expect the network to provide a level of control over her or his communications affairs. For example, the ability to tell the network that the customer is now in *business mode* or *social mode* with access to a different range of services, and the ability of specifying in these situations who can and, equally importantly, who cannot contact the customer.

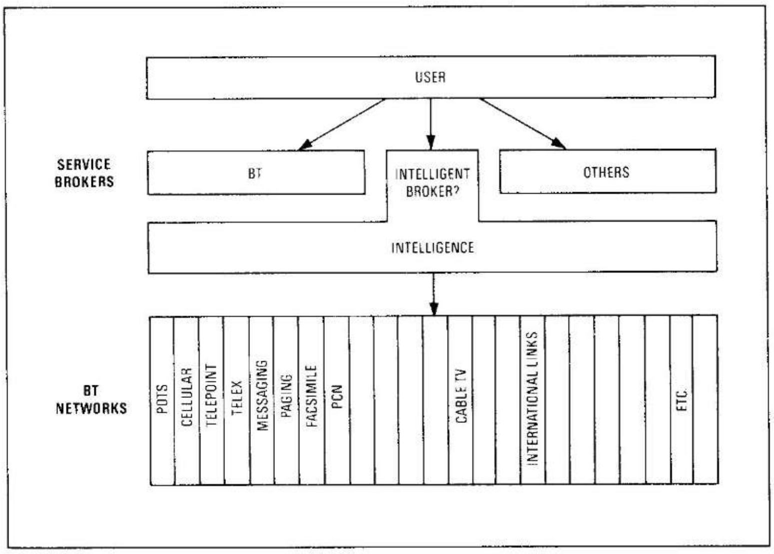
SERVICE PROVIDERS

Someone will have to provide these services for social and business users. BT already acts as a service provider, but there are a growing number of third parties providing services for business, social and domestic occasions.

At its simplest this may be in the form of a service broker who will put together a personalised package of existing network services by acting as the systems manager and technical expert, providing a layer between the user and the networks. The telecommunications manager takes on some of this role within a company, but there is an opportunity for similar roles for BT and other companies servicing residential customers and smaller businesses.

Over time, this brokerage role and many of the control features could be absorbed into an intelligence layer overlaying all the networks and providing a user-friendly interface to the network with services tailored to the individual. This intelligence layer takes on the role of a broker as shown in Figure 2 which is a concept we shall revisit when looking at the corporate customer.

Figure 2
Intelligence layer and service brokerage



Another group of service providers will be looking to run the actual value-added services for both residential and business customers, including banking, shopping, information and bureau facilities. These companies will be looking at BT's network, particularly with the advent of intelligent network databases, to provide the platform for introducing new services rapidly to a wide market and to provide the support, management and billing services to match.

The major issues for the network in supporting these emerging services will include:

- the ability to bill both the end user and the service provider;
- management of the service network to ensure maximum coverage and availability;
- control for the individual and the provider of the range of services to be accessed; and
- ease and speed of introduction of new services.

THE CORPORATE CUSTOMER

We turn to look now at the corporate customer represented by the telecommunications manager or information services director, responsible for the communications infrastructure for a company—the corporate network.

Communication Value Chains

Businesses are increasingly taking a strategic look at where communications can help improve the effectiveness of their operations, reducing costs and improving profitability. Each firm is a collection of activities that are undertaken to design, produce, market, deliver and support its products and services. These can be described as a value chain which identifies:

(*a*) primary activities, such as raw material delivery, production line, warehousing and delivery;

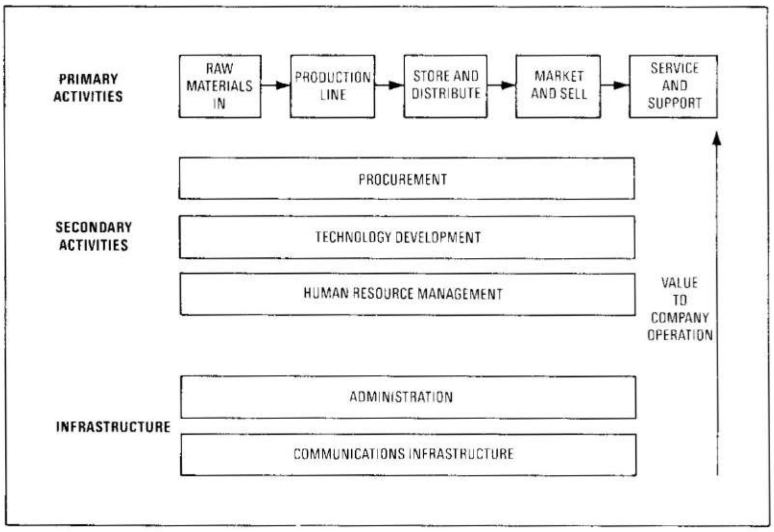


Figure 3—Generic value chain for a manufacturer

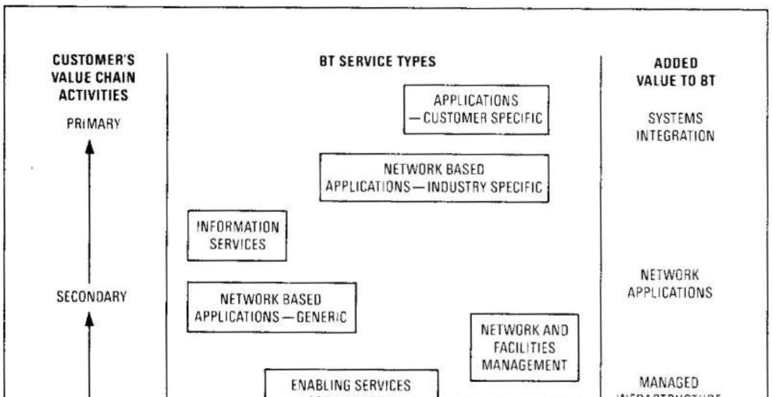


Figure 4—BT service value chain

(*b*) secondary activities such as research and development, finance and personnel; and

(*c*) infrastructure activities such as administration and communications networks.

Generally, the higher the activity in the value chain, the more specific will that activity be to the type of industry and the more value it will add in terms of revenue or profit to the company's operation. Figure 3 illustrates a generic value chain for a manufacturer.

This analysis can help identify where communications and communication-based applications can significantly enhance the performance of a company; for example, through better contact with suppliers in the buying department or by introducing telemarketing services to improve customer contact. Each industry has its own particular value chain and hence differs in the ways in which networks and the solutions based upon them can be used. Generally, the higher in the value chain of a company is the impact of a potential application, the more specific to that firm it will be, and more tailoring will be needed of any communications solution.

Alongside the value chain we can put the range of services that BT can supply, ranging from network components, managed network infrastructure and network-based applications through to specific systems integration projects. Figure 4 shows a simplified representation.

Although this article is concerned with the development of network services, these provide the essential infrastructure on which the higher-value applications are based.

A Customer Model for Network Infrastructure

Traditionally, BT has provided exchange lines, packet services, private circuits and associated equipment such as switches and multiplexors as components of a company's corporate network for integration by the customer. The continuing requirement from a majority of corporate customers will be for reliable and cost effective service from these network components, supported by easy provisioning, and speedy delivery and repair.

Taking a wider view of networks as providing an enabling infrastructure for a firm is an opportunity for BT to assist the corporate customer to design, install and run the telecommunications and communications facilities for her or his company. To do this we require a model, derived from a customer perspective, of the network services and how they fit together. This will be a conceptual model for thinking about possible service developments, not a description of the physical realisation of the networks which, again, is BT's problem, not that of the corporate customer. Similarly, in good marketing fashion, we are ignoring any regulatory or technical problems.

Table 2 shows some of the many potential network building blocks which have to be considered, and which we can regard as core network services. Currently, the telecommunications manager is faced with a number of network bearers coming into the company's sites. If we pick up the theme of the intelligence layer introduced for the individual customer, then we can visualise a box on the customer's premises, connected by a large capacity pipe to the local exchange, as illustrated in Figure 5. Conceptually, a corporate customer, will plug the PBX or office controller into this *intelli-port* giving access to all his or her network services: switched, private, PSS and even wideband videoconferencing.

TABLE 2
Examples of Network Building Blocks

- Modern exchanges based on System X and AXE10 switches and the enhancement of electronic switches (TXE4/4A).
- The DMSU chain of digital trunk exchanges.
- KiloStream and MegaStream in the UK.
- International digital private circuits.
- The deployment of optical fibre to business sites in London and other business areas.
- The introduction of Centrex services.
- The potential for virtual private networking.
- Intelligent network database facilities.
- ISDN treated as digital exchange lines.
- The DDSN networks of 5ESS switches providing LinkLine.
- The mobile and radio networks.
- Managed network services based on packet switching.

Flexibility Services

A first step is to add flexibility. If we go back to our picture of the networks, each site currently has a variety of lines for different services, with little or no flexibility to change or mix the services. Part of the model is a service switch which can be programmed to give the customer precisely the range of private, switched and packet services that are needed. This also includes, for example, the ability to group multiple channels into a composite broadband pipe for applications such as videoconferencing as compression techniques improve.

Through the intelli-port, the telecommunications manager will be able to add and delete circuits to suit the company's demands as they change. Initially, this may be by agreeing and setting up a diary of requests which BT, acting as the service broker, then implements. In the future, the telecommunications manager will expect to be able to programme personally the exact configuration of communications that is most cost effective to the company and to reconfigure them to match changing trading conditions. The requirement here is flexibility and rapid provisioning.

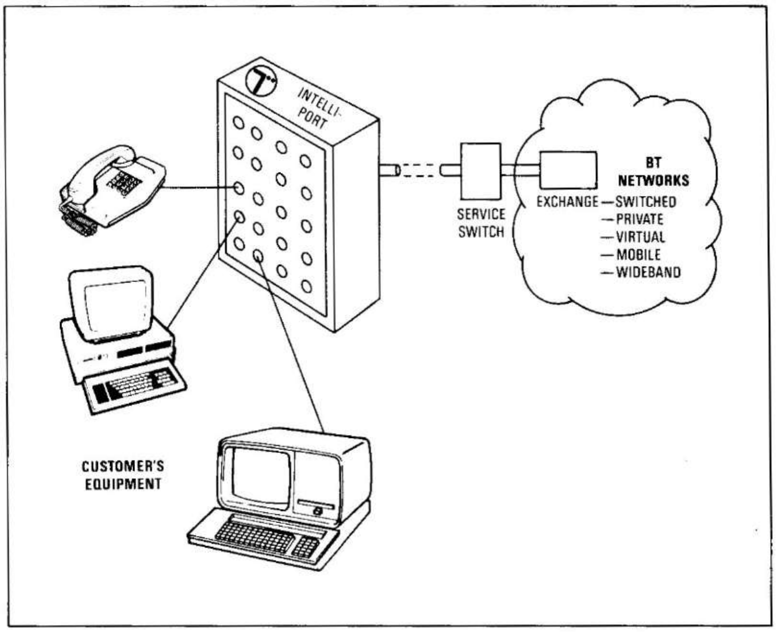
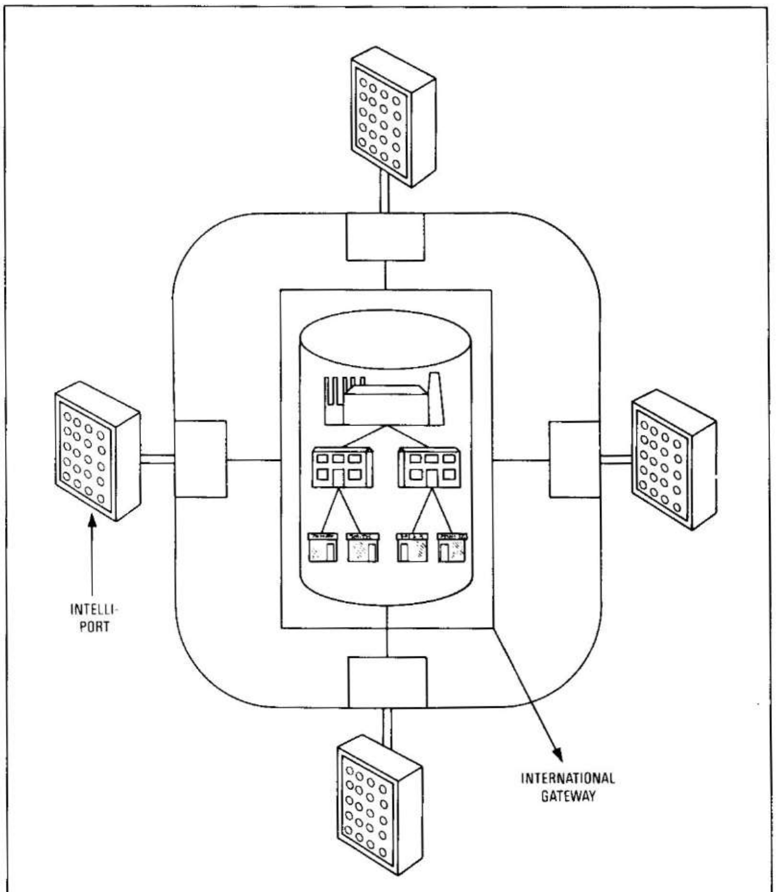


Figure 5
Concept of intelli-port: intelligent gateway to network services

Multi-site and Extended Enterprises

This will provide some flexibility and more efficient management of services into and out of a single site. Further advances will allow a model of a company's complete national network and its various patterns of traffic to be maintained on a central database. As shown in Figure 6, this will mean that flexibility can be extended from a single site to the total corporate network.

Figure 6
Extension to a corporate network



We can also use the concept of value chains to look at wider developments in corporate networks. Communications are being increasingly used to lock different companies together; for example, a retailer with its many suppliers. Putting together the value chains of a supplier, a manufacturer and a retailer can highlight ways in which effectiveness can be further improved through the use of communications. This has resulted in extended enterprises as illustrated in Figure 7, joining together the corporate networks of suppliers, producers and distributors.

Increasingly, these corporate networks are international in nature. Those parts of the network outside the UK will need to be built with locally available private circuits or managed data networks and connected with the UK operation through BT's international private circuits. Hence, as well as having the service support outside the UK, a consideration for network development is to ensure that transparent interconnection is possible and that standards are developed which help this process across national boundaries.

Communication Management Systems

Now that a model for designing the network infrastructure for a company or an extended enterprise has been established, we turn now to the management of these facilities. We are assuming that the intelli-port gives access to a cost management module with billing facilities able to match the customer's specific range and flexibility of services.

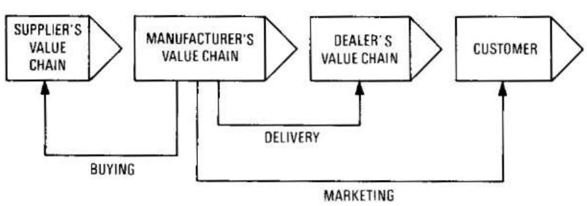


Figure 7—Extended enterprises and linked value chains

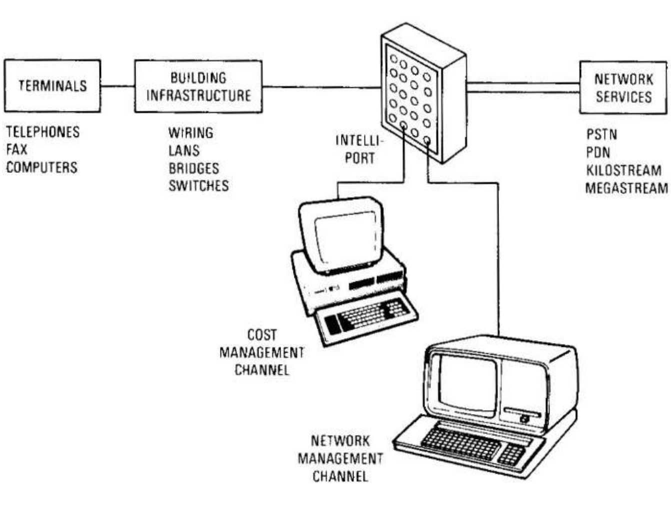


Figure 8—Reach of communication management system

However, BT also has sophisticated computer systems to monitor and manage the circuits and the wide range of equipment such as multiplexors, site controllers, PABXs, packet assembler/disassemblers (PADs) and LANs that go to make up an end-to-end communications infrastructure.

Network management centres established for internal use by BT could be used for providing network management services to customers. Conceptually, the intelli-port shown in Figure 8 would have a channel for allowing management of the customer's facilities through the building infrastructure and down to the terminals, either by the customer or by BT on the customer's behalf.

Standards will have a major impact in this area where BT's network architecture will evolve to ensure connectability of the wide range of equipment and circuits in the modern network.

The Corporate Customer as Service Broker

Digital exchanges will allow new types of service to be introduced. Facilities such as three-way calling and call diversion are already available to a number of small businesses and the executive at home, providing some of the facilities of a modern switchboard.

Call management services typical of those to be found on an advanced PABX may be provided through the network as Centrex services which can replace a PBX, provide supplementary capacity to an existing PBX on an expanding site or be an overlay for new services at another location. There will also be an evolving range of new voice, messaging, bureau, information and data services which will become available over the next five years. These can be used in conjunction with a company's existing facilities through a PBX or delivered through Centrex facilities.

The network will be required to have the ability to introduce these services rapidly for the corporate customer, providing the appropriate management and billing support. The corporate customer then acts in a similar role to the service broker by providing individual tailored services to the business individuals in the company. The needs of the business individual investigated earlier are thus relevant for the designer of corporate networks; this may in the future include access to the corporate services from anywhere in the world, potentially through a personal communicator.

Smart Components

Further still up the company's value chain are specific applications such as point-of-sale sys-

tems for retailers, just-in-time ordering for manufacturers, and dealing rooms for institutional finance. It is not the purpose of this article to go into detail about BT's systems integration capability, but there are aspects of network development which could assist these applications. For example, the network could automatically support protocol conversion, various data speeds and transaction types ranging through alarm monitoring, EFTPOS, videotext and file transfers. Effectively, a number of *smartlines* would be created as shown in Figure 9, each catering for a single or small range of applications, replacing the need for ancillary equipment.

Some of these facilities are already available on the public data network, but could be provided for the switched and private networks to give a spread of speeds, data transfer and costs that are needed to support a complete range of applications. Again the intelli-port would give transparent access to the appropriate smart component.

Intelligent Services on the Digital Networks?

So far, we have not explicitly mentioned the integrated services digital network (ISDN). We have assumed that the digital network elements, the ability to provide 64 kbit/s channels, are considered as digital exchange lines either to a single socket or in bulk to a PBX. This will allow certain data services and applications to be run on the network of which these circuits are components.

If, however, we consider the integrated and services aspects, it allows us to pull together a view of the intelligent network which includes switched, dedicated and packet bearers. In the model shown in Figure 10, the corporate customer accesses the networks through the intelli-port which provides the intelligence layer offering flexibility, reconfiguration and control over the full range of services. The way that BT chooses to carry the traffic across the network has become transparent to the user.

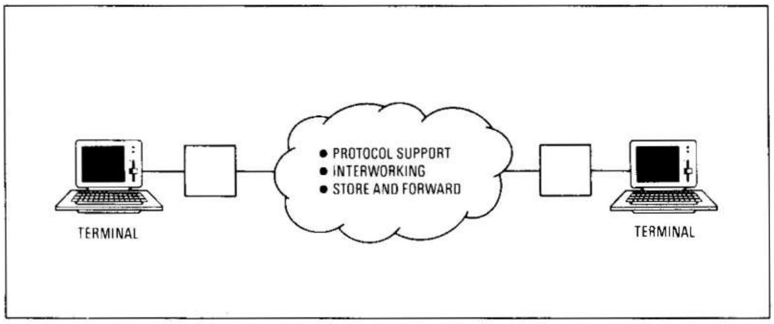


Figure 9
Smart components for a corporate network

If we put these concepts together, they form an overall set of services delivered to the customer's premises by a PBX or Centrex, with extended links through fixed and mobile facilities and transparently integrating:

(*a*) (digital) circuit components from the switched, private, virtual, wideband and packet networks;

(*b*) mobile and radio local ends;

(*c*) common access capabilities and services;

(*d*) intelligent network databases for network control and rapid introduction of new services; and

(*e*) protocol and other computer support facilities within the network.

The model also includes customer-to-exchange signalling compatible with CCITT Signalling System No. 7 allowing services to be conducted across the network independent of the bearers.

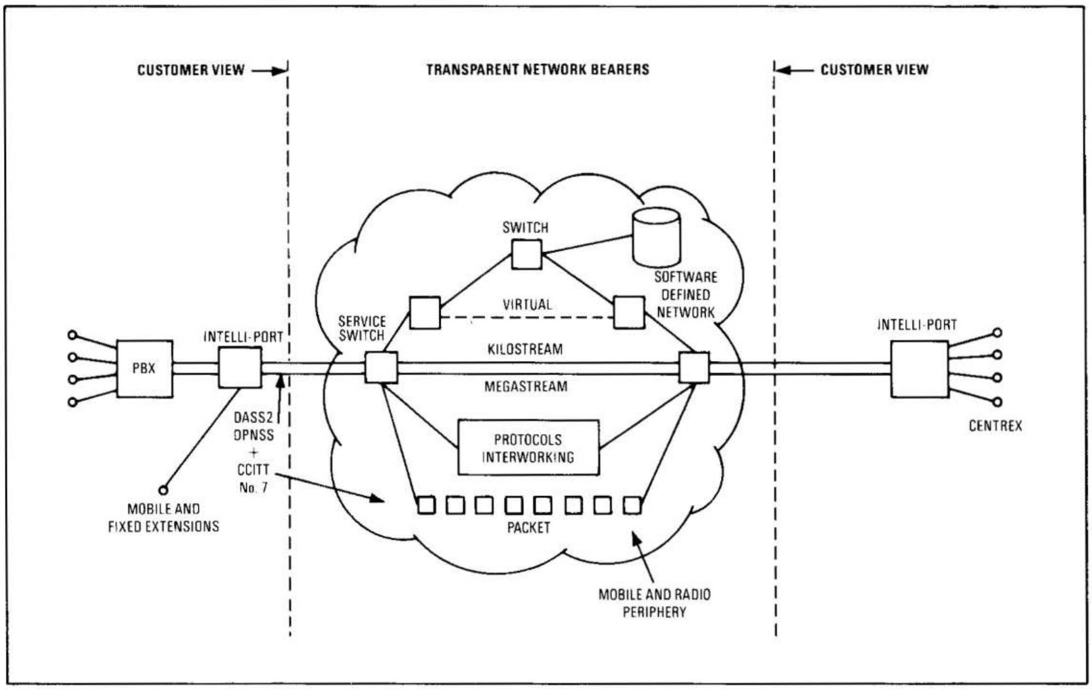


Figure 10
The intelligent gateway to BT's network service

CONCLUSION

This article has presented a simplified view of customer trends in the individual and corporate customer market-places and their likely impacts on network developments.

The key feature of the individual is that she or he takes on a variety of roles: in the home, the office or while travelling. Most individuals will still require an invisible hassle-free basic service at a cost reflecting relatively low interest in telephones. However, there are communications intensive individuals in both residential and business situations who will take up new services more rapidly. The needs of the individual market will therefore include:

- quality and reliability of basic services at low cost;
- range of services tailored to the different roles being played by the individual;
- ease of access and transparency of how the services are delivered;
- control by the individual of his or her communication environment;
- numbering schemes for each individual rather than a household;
- billing facilities to match individual services;
- location-independent services; and
- service brokerage either by a service provider or by a network intelligence layer.

The majority of corporate customers are still looking to BT to provide the components of their corporate networks, where quality and reliability are key. Indeed these issues must be addressed before any of the higher-value roles discussed in the article can be successfully introduced. The key issues for future development from the corporate customer include:

- flexibility to introduce and reconfigure services;
- reduced complexity;
- control and management;
- development of standards to ensure network components and systems are compatible; and
- service brokerage capabilities for the telecommunications manager.

Common themes have surfaced in both market areas. Quality and reliability of the networks are essential, but there are also emerging areas for future development in control, reduced complexity and service brokerage provided by an intelligence layer in the network.

Biography

Jon Chidley has recently moved to Corporate Strategy as General Manager of the Strategic Market Development Unit. Through the Director of Corporate Strategy, he is responsible for developing market positioning for BT world-wide. This brings him into contact with marketing, network and technology groups across BT providing a customer focus to the evolution of networks and technology. Before joining BT, he was responsible for marketing Thorntons Chocolates and he has worked as a marketing consultant with leading UK and international retailers and information technology companies. He was a research mathematician at Durham and Warwick Universities and received the Gold Medal of the Market Research Society for a paper on the application of catastrophe theory to customer attitude studies.

British Telecom International—Broadcast and Visual Services

M. TAYLOR†

This article reviews British Telecom International's Broadcast and Visual Services (BVS), which, through its five specialist products/services, plays an important role in the distribution of visual, audio and data services via satellite. The five BVS product units—TV Distribution Services, Broadcast Services, International Videoconferencing, Business Television and Satellite Data Services—are targetted at the needs of the individual consumer and corporate customer alike. BTI bases its portfolio of customised network facilities on 25 years of experience in running satellite communications systems. Since the EARLYBIRD satellite in 1965, BTI's role has developed and diversified to cater for a fragmented market.

INTRODUCTION

As a unit within British Telecom International (BTI), Broadcast and Visual Services (BVS) plays an important role in the distribution of visual, audio and data services via satellite.

BVS comprises five specialist products/services in the field of satellite distribution, catering to a broad-range of customer requirements. Firstly, through TV Distribution Services, BVS is able to bring entertainment television and radio, via satellite, directly into homes throughout Europe. Secondly, BVS's Broadcast Services enables broadcasters and international news agencies to relay, via satellite, news, sports and special events coverage on 'occasional use' satellite capacity to world-wide destinations. Thirdly, International Video Conferencing provides, via satellite, inter- and intra-company visual communications for face-to-face meetings across the globe. The fourth service, Business Television, provides permanent and *ad hoc* networks for, *inter alia*, company press launches and staff training. Finally, Satellite Data Services (SDS), similarly utilising state-of-the-art satellite technology, embodies a new BVS service initiative, to meet the emergent needs of the business customer who requires the distribution and reception of data signals on small satellite antenna.

The five BVS service groups are targetted to meet the needs of the individual consumer and corporate customer alike and, together, comprise a portfolio of custom network facilities tailored to specific market needs. British Telecom's understanding of these market requirements is solidly based on 25 years of experience in running satellite communications systems.

During the last quarter of a century, BTI has continually responded to the needs of the satellite communications industry as well as stimulating demand in the market-place through pro-active research in satellite technology. The BVS Unit provides a focal point for the present and future development of satellite distribution services in both the broadcasting and data fields.

The arrival of the EARLYBIRD satellite in 1965, and the involvement of BTI' s forerunner organisation in that project, provided the foundations on which the BT involvement in the satellite communications industry has become so extensive. From the provision of short-length transmissions across the Atlantic via the EARLYBIRD satellite, BTI confirmed its central role in the future of distribution via satellite facilities. It is in the light of BTI's traditional role in this field that BVS emerged as an 'umbrella' group, catering to the diverse requirements of a diverse market.

TV DISTRIBUTION SERVICES

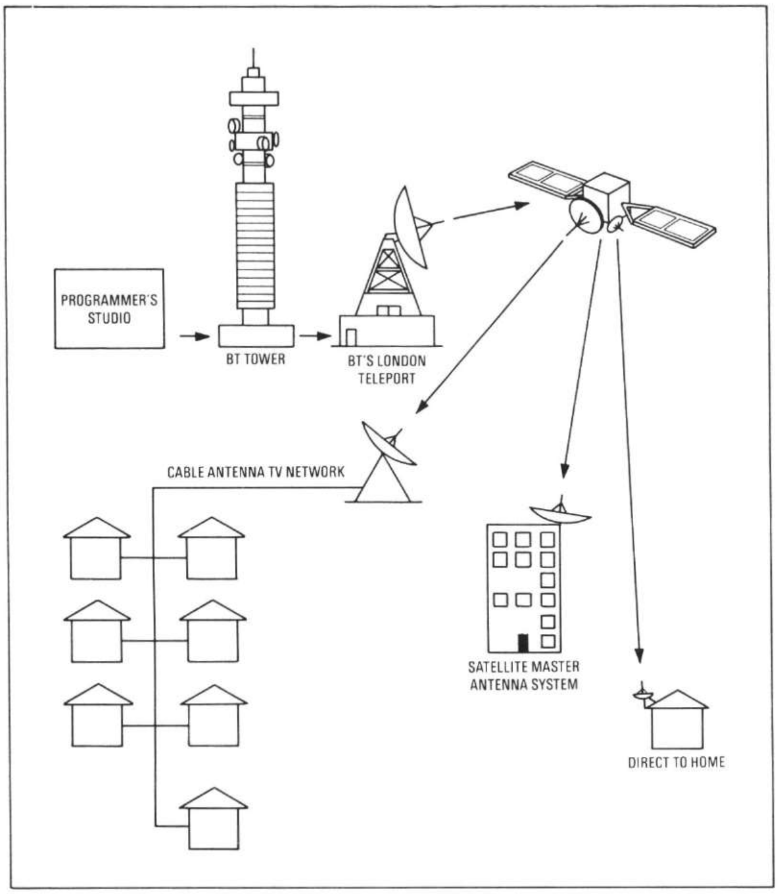
In 1982, BTI established the TV Distribution Services Department to meet the needs of the burgeoning satellite TV market-place. TV Distribution Services soon established itself in the satellite communications industry through the provision of lower-power satellite capacity, via INTELSAT and EUTELSAT satellites, to programmers such as SKY Television and SUPER-CHANNEL, on a 24-hour-per-day basis. Prospective satellite TV programmers soon realised the potential market that could be reached, via such satellite capacity, due to the number of homes accessible by cable networks across Europe. Such networks were able to receive satellite television transmissions via either INTELSAT or EUTELSAT for subsequent distribution into European homes.

The attractiveness of the service offered by BTI's TV Distribution Services Department is also founded upon the extensive range of facilities at the disposal of BTI; these facilities are themselves the result of BT's long-term commitment to the advancement of the satellite communications industry. The TV Distribution

† Broadcast and Visual Services, British Telecom International

Services 'package' (see Figure 1) begins at the British Telecom Tower, the hub of the UK telecommunications network, where video and audio signals are received from the customers' studio or facilities house. From BT Tower, programmers' signals are carried via terrestrial or microwave links to BT's London Teleport (see Figure 2), located in the docklands at North Woolwich. The BT London Teleport was opened in 1984, to complement BT's existing satellite earth stations at Goonhilly in Cornwall and Madley in Herefordshire. The construction of the London Teleport was itself based upon the latest satellite communications technology, permitting its location close to the heart of London, the focal point of the European media industry. From BT's London Teleport, the programmer's signal is transmitted to satellite capacity via a 13 m uplink antenna. The BT London Teleport currently houses one 8 m, one 11 m and four 13 m uplink antennas and has capacity for a further two, in order that it may meet the demands of the expanding satellite television and radio market-place. The ability to make use of this extensive range of advanced facilities, coupled with BT's expertise in the satellite TV distribution field, has resulted in the ability of BT to meet the specific requirements of individual customers. Many European satellite TV programmers have funded their projects by aiming their service at specified locations. Hence, BT meets the need for 'addressability' of service, through the utilisation of secure systems. Examples of such systems are B-MAC, D2-MAC and SAVE.

Figure 1
Signal routing for BTI's TV Distribution Services



TV Distribution Services was heavily involved with the marketing arrangements for the ASTRA satellite, launched in December 1988. BTI's joint venture agreement with *Societé Européene des Satellites* (SES), the private company owning the ASTRA satellite, enabled BT to market 11 of the 16 channels available to programmers on ASTRA to UK-based satellite TV programmers. TV Distribution Services attracted programmers to ASTRA, with its medium-power transmission, offering the possibility of small-dish (60 cm) reception in many of Europe's 120 million homes. SES had turned to BT on the basis of its involvement, through TV Distribution Services, in the growth of the European satellite TV market since 1982.

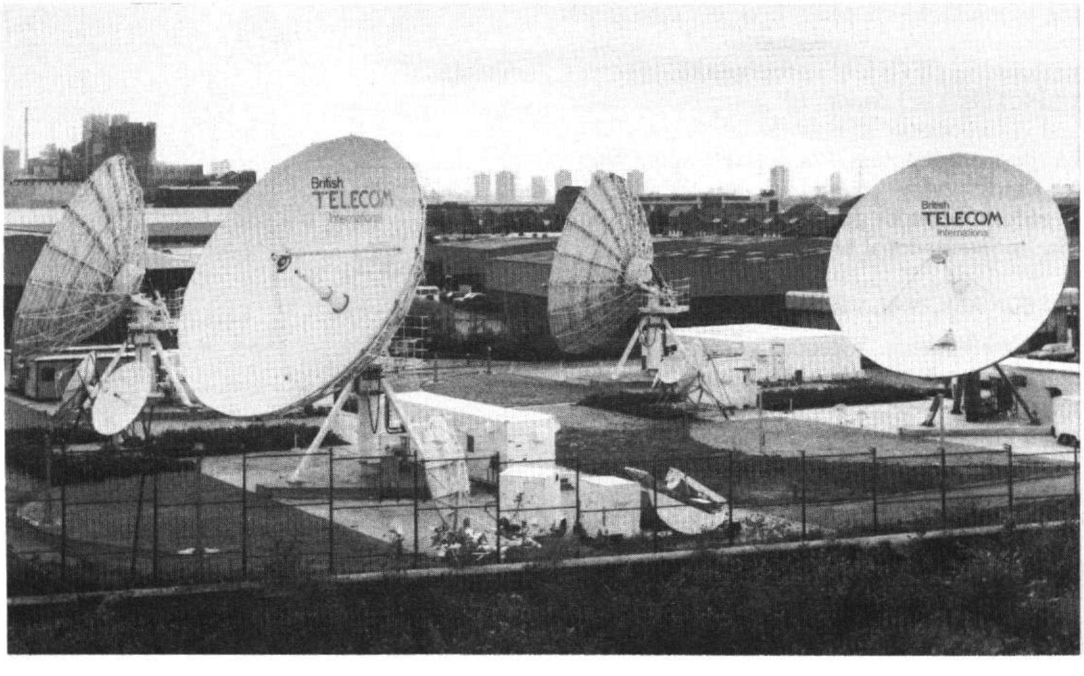


Figure 2
London Teleport

The ability of BT to successfully market the available satellite capacity to programmers has been a contributory factor to the success and rapid growth of the satellite TV market-place. BT continues to provide programmers with lower-power satellite capacity via the existing EUTELSAT I and INTELSAT V series satellites as well as that of the ASTRA satellite. TV Distribution Services is also currently marketing medium-power EUTELSAT II series satellite capacity.

BROADCAST SERVICES

BVS's Broadcast Services offers an equally customised service to meet the specified needs of its customers. Broadcast Services provides high-quality global television and sound transmission services, via satellite, microwave and cable links, transmitting and receiving more than 120 hours of programmes daily. Broadcast Services has built up a strong reputation among international broadcasters for its technical capability, professional experience, operational flexibility and swiftness of response to meet the requirements of customers.

Broadcast Services' operations fall into four categories: news, one-off events such as the Olympic Games, continuous programme networking and private transmissions such as multinational product launches. Broadcast Services has made London the international hub for transmission between Europe and North America, the Middle East, Africa and the Indian subcontinent. Major US network television companies base their European operations in London to take full advantage of BT's broadcast facilities. BT's Broadcast Services is an integral part of the global broadcasting revolution and makes full use of the earth stations at Goonhilly, Madley and the London Teleport. Broadcast Services also utilise BT's fleet of transportable earth stations as well as a satellite news-gathering terminal which packs into just nine flight cases. Using the international sound and international television programme centres (ISPC/ITPC) in London, BT also provides audio and vision circuits all over the world. The ISPC has permanent access, via 3·4 kHz audio links, to almost every country in the world. BTI Broadcast Services provides a truly global service to international broadcasters.

INTERNATIONAL VIDEOCONFERENCING

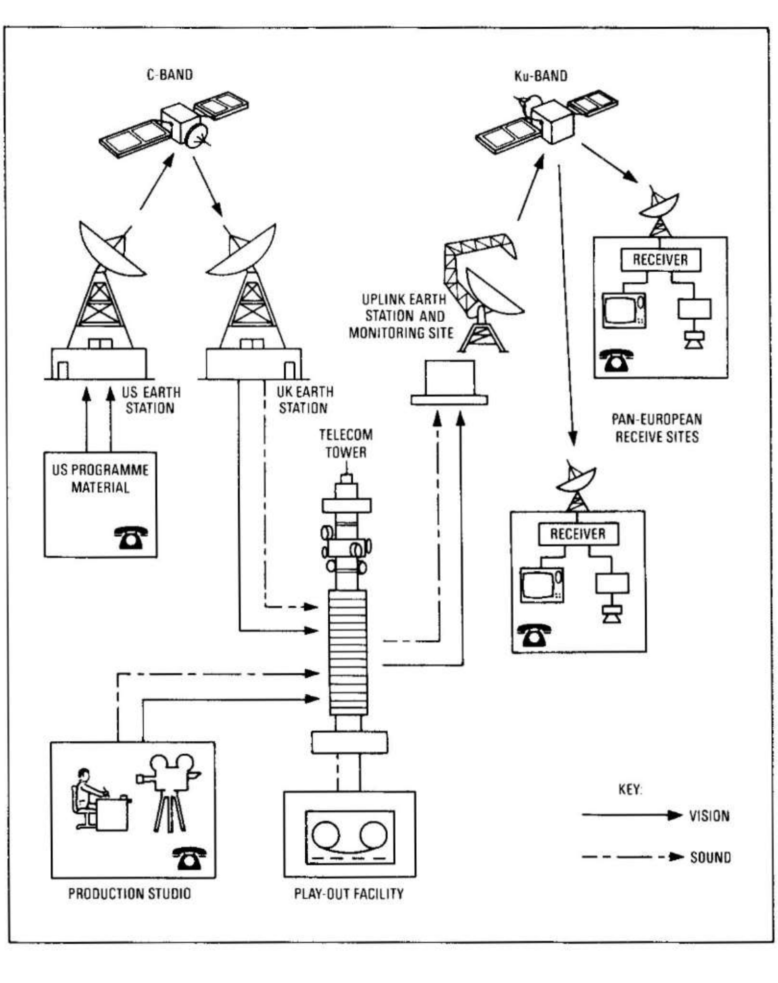
The International Videoconferencing Department caters for the demands of business customers. 'Face-to-face' videoconferencing allows small groups of business customers in a variety of locations, to hold meetings using two-way full-motion video and audio communications, via satellite or land lines, between British Telecom's public videoconferencing centres or the in-house facilities of corporate customers and major business centres internationally across Europe, North America and the Far East. As more and more business organisations realise the potential advantages of BTI's internal videoconferencing service in areas such as management and administration, or training, the service will grow to meet the demand.

BT's International Videoconferencing Department provides the expertise and can also provide the essential hardware and transmission circuits to business customers.

BUSINESS TELEVISION

The fourth service offered by BVS is Business Television. A typical configuration is shown in Figure 3. Business Television is a communications medium, using conventional satellite television broadcasting techniques. Business Television broadcasts are live and interactive, allowing viewers to ask questions and receive an immediate response via conventional telephone lines. Programmes can also be recorded for subsequent transmission, allowing for flexibility of programming and the ability to disseminate timely information. During the 1987 stock market 'crash', many American financial companies needed to calm their staff and clients within 24 hours. The only fast and efficient medium available was Business Television. At 16.15 hours when the market closed, securities experts were on air, live, putting the crash in perspective and restoring a sense of stability. BTI's Business Television Department offers the swiftness of response essential to contemporary

Figure 3
Business Television network



international business organisations. Supported by BT's depth of resources, Business Television can provide all elements of the service, from transmission with production to total network management, either for a one-off event or a permanent installation. The business-to-business services offered by BTI are set to expand to meet the increased corporate demand for improved communications technology.

SATELLITE DATA SERVICES

BVS's Satellite Data Services (SDS) is the latest product initiative aimed at catering for the needs of the business community. SDS offers the flexibility demanded by the business community in the transmission of data.

SDS can offer transmission of data via narrowcasting, one-way point-to-multipoint or a two-way point-to-multipoint interactive service. All of these service packages are based on the concept of the distribution of data over satellite and the utilisation of small satellite terminals located on users' premises.

SDS transmits data at a wide range of speeds, according to customer requirements, ranging from 1200 bit/s to 2 Mbit/s and beyond. SDS provides full network management, based upon network configuration, traffic re-loadings, VSAT (de) authorisations, billings and statistics. The narrowcasting service utilises spare capacity available within standard satellite TV signals. As BT provides the largest satellite television uplink service in the world, SDS is able to use the plethora of available capacity, whether vertical blanking interval (VBI) teletext lines, TV sub-carriers, or the data carried MAC encryption systems located at the London Teleport, to the advantage of the data customer. Economies of scale and associated pricing benefits are results of the sheer volume of available capacity. The narrowcasting services, as with satellite television transmissions via ASTRA, utilise dishes sometimes smaller than 60 cm in diameter, located on the customers' premises.

CONCLUSION

Broadcast and Visual Services, therefore, offers complete service packages to a diverse customer base. The BVS products have been developed to meet the disparate needs of the satellite TV/radio programmer, international news agencies, corporate customers and small businesses. BTI provides the widest range of satellite distribution services available, with Broadcast and Visual Services providing a unique range of products for customer usage.

Biography

Michael Taylor joined British Telecom International's TV Distribution Services in 1988 after graduating from the University of Exeter with an integrated degree in Politics, Philosophy and History. Michael has assumed responsibility for several customer accounts and is involved in contract negotiations for the provision of satellite-delivered television and audio distribution services to new customers. Michael also liaises closely with European PTTs, gaining their co-operation to enable the co-ordinated reception of satellite television and audio services throughout Europe.

Network Administration Implementation Programme

A. G. BEALBY†

British Telecom's modern network requires new administration techniques to ensure its full potential is achieved. This article outlines the implementation programme that the BT Management Board has recently approved to deliver the first phase of the new network administration.

INTRODUCTION

The introduction into the British Telecom network of digital technology systems has resulted in a need for radical reappraisal of the way the network is administered. The network forms the central core of BT's business, and its efficient management and administration is fundamental to the future success of the company.

The Network Administration Implementation Programme (NAIP) has been established to control and sponsor the development of network administration systems. This article explains the background to the programme, its structure, and progress to date.

NEED FOR CHANGE

Historically, administration of BT's networks has been locally controlled. Many procedures were developed for use in an analogue or electromechanical environment and are outmoded. The technology imposed a multiplicity of control points which made centralised operation and maintenance of the network impractical. Many procedures are paper-based and time-consuming. The computer systems currently in use were often developed in isolation and are not always compatible.

By the mid-1990s, the network will be almost exclusively digital, with optical fibre or microwave inter-switch transmission and intelligent network databases. The network will therefore provide the business with the flexibility and sophistication it needs to provide an attractive revenue-earning range of quality customer services at reasonable cost. The network has many different components and, to provide the seamless service BT's customers expect, the network administration procedures need to be streamlined, integrated and automated.

NETWORK ADMINISTRATION TASK FORCE (NATF)

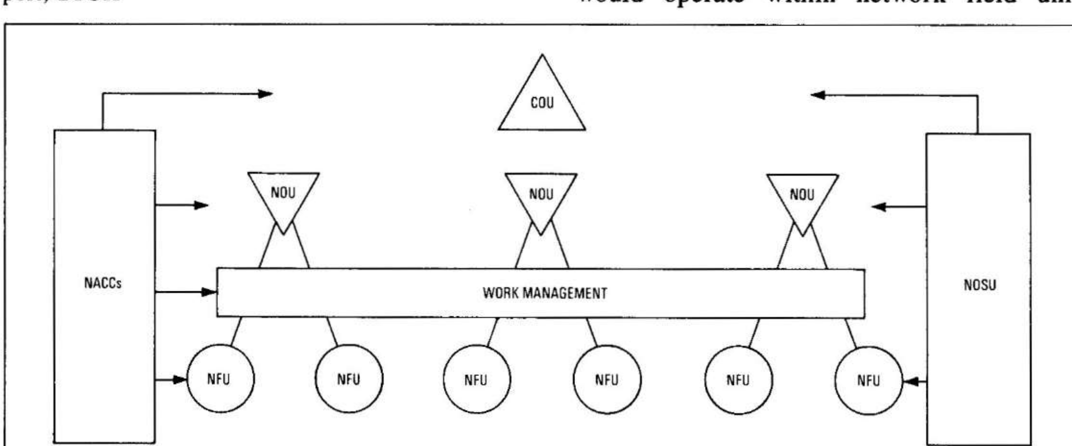
Recognising the need for change, the Network Administration Task Force (NATF) was established in 1986 to examine the situation in depth and produce recommendations to shape the digital environment of the 1990s. The Task Force comprised senior managers representing a wide spectrum of BT network interests. Its objective was to review the way in which BT had to adapt the operation of its network and the systems which support it, to enable the emerging digital network to operate at maximum benefit to the customer.

NATF RECOMMENDATIONS

The Task Force report, produced in 1987, contained over 100 recommendations and was endorsed by the BT Management Board. Its principal recommendations were as follows:

A new three-tier operational structure would be established (see Figure 1). Networking staff would operate within network field units

† General Manager, Network Operations Support, BTUK



COU: Central operations unit NOU: Network operations unit NFU: Network field unit
NACC: Network administration computer centre NOSU: Network operations support unit

Figure 1
Network administration structure

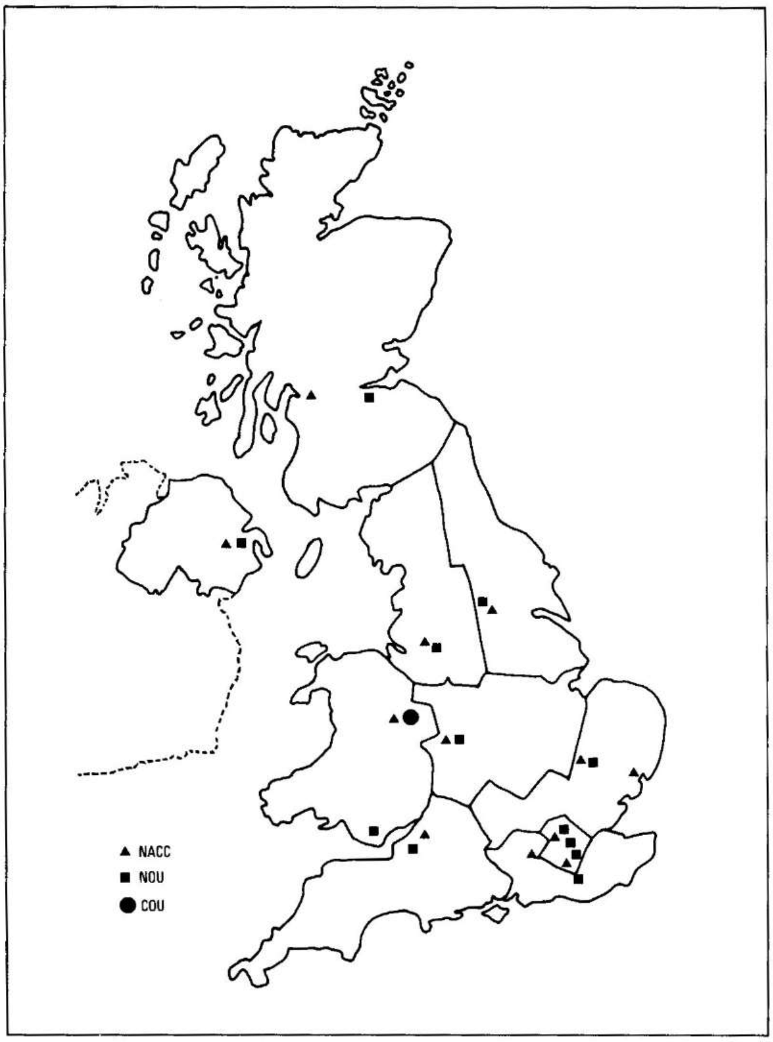


Figure 2 NOU catchment areas

(NFUs). There would be about 50 of these throughout the country. The management of the network would be centred in 12 network operations units (NOUs) where teams of network administration experts would control activities for their own catchment areas (see Figure 2). Operations that require a national picture, for example, network traffic management, would be located in the central operations unit (COU).

These three operational tiers would be supported by 12 network administration computer centres (NACCs). Dedicated and integrated computer systems would facilitate the real-time management of network traffic, real-time surveillance of transmission and remote provision and repair at any point on the network. All new computer systems would be network based, thus removing the distinction caused by internal organisational divisions such as local and trunk. They would be designed to dovetail with customer-facing systems, such as Customer Services System (CSS), and to maximise the potential for reconfiguration of the network, to meet customer needs.

Lastly, a network operations support unit (NOSU) would be created, to develop network policy and issue and co-ordinate information and guidance.

NETWORK ADMINISTRATION IMPLEMENTATION PROGRAMME (NAIP)

The NAIP was set up in 1988 to develop a strategy based on the NATF proposals and to oversee the implementation of that strategy. An Executive Group led by the BTUK Assistant Managing Director (Operations) and the Director (Network) has overall responsibility. A Core Team, led by the author, directs and controls the programme. The detailed implementation planning is being carried out by functional working groups (FWGs) made up of managers from District, Trunk Region, Territory and Headquarters units (see Figure 3). Close HQ/field team working is a feature of the project. It must be stressed that work on NAIP is not proceeding in isolation—there are links to other major initiatives such as Strategic Systems Planning, Local Line Task Force, and Work Management, to ensure a coherent way forward.

OPERATIONAL RELATIONSHIPS

Although there is still much work to be done within the FWGs, the relationship between the operational tiers is beginning to emerge. These three elements are inter-dependent and will support each other to facilitate a seamless service to the customer.

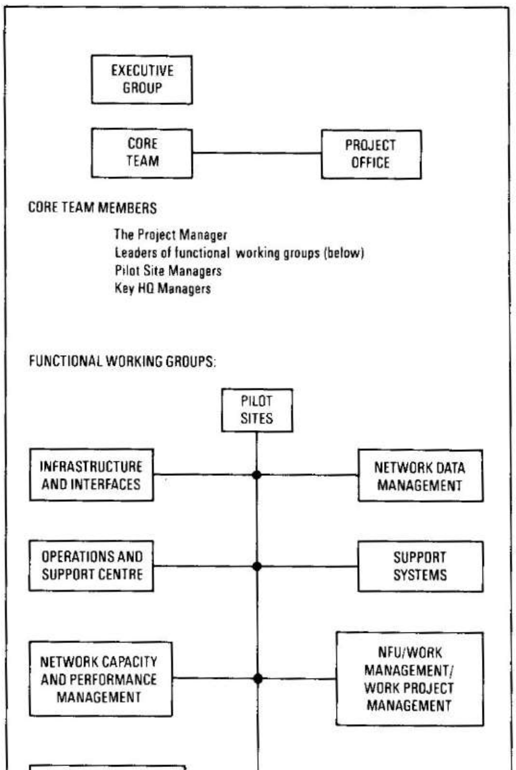


Figure 3—NAIP organisation

The COU will take responsibility for those operational functions which affect the totality of the network and which extend across NOU catchment area boundaries.

NOUs and NFUs will, together, ensure the smooth running of the network within the NOU catchment area. The NOU will oversee and control maintenance and operation support, data management, capacity management and the real-time optimum use of plant. Having an overall picture of the network within their catchment area, NOU staff will be able to decide on work priorities. A sophisticated work management computer system will be used to match resource to demand, allocating and issuing work to NFU staff in the most effective manner. Wherever practical, the NOU will effect remote manipulation of the network (for example, to re-route traffic, countering local congestion or to achieve end-to-end reconfiguration of customers' network services).

An NFU could be defined as 'a group of people carrying out network activities that cannot be handled remotely'. Although there may be some accommodation at a central point, it is expected that the majority of NFU staff will spend most of their time in the field, in a mobile multi-skilled role. By the mid-1990s, the NFU will deal with local/trunk switching and transmission, maintenance and construction; power and building engineering services maintenance and construction; circuit provision; special services maintenance and provision; and customer connection in the network. At this point in time, the local access network organisation is being independently reviewed.

NAIP STRATEGY—A 'STEP BY STEP' APPROACH

The new network administration strategy is being implemented in stages. For example, the network operations centre is now monitoring and controlling network traffic, fulfilling part of the COU role. NACCs are already established across the country and two pilot NOUs have been set up at Walsall (West Midlands) and Manchester (North West). A third pilot, in London, is due to open in mid-1990 to ensure the needs of the capital are met. Operations support centres (OSCs) have been established at the pilots, pulling together various functions previously handled at different locations within their respective NOU catchment areas.

The purpose of the pilot NOUs is to provide a basic resource and infrastructure to test and refine the various systems, practices and procedures being developed for NAIP's functional working groups.

Districts and Trunk Regions have been asked to submit details of methods and practices for trialling and evaluation. The aim is to establish a range of 'standard practices' for national rollout, to provide a focus for development resources and minimise expenditure on other systems and procedures.

National rollout of the other NOUs will start in mid-1990, based on the results of the pilot site trials. Running parallel with pilot activities and subsequent NOU rollout, the FWGs will continue to work on developing the procedures and systems to meet the NATF's vision of network administration.

NOU NATIONAL ROLLOUT

Functionality will be rolled out to NOUs on a phased basis. Although standardisation is a major facet of the NATF recommendations, it has been recognised that Districts and Trunk Regions will have their own unique starting points when setting up NOUs. However, certain features are considered essential for every NOU. The phased approach means rolling out functions in stages, having previously tested, evaluated and agreed them at the pilots.

NOU sites have been selected and are as follows:

Belfast	Edinburgh
Bristol	Leeds
Cambridge	London (three sites being confirmed)
Cardiff	Walsall (pilot)
Crawley	Manchester (pilot)

These are expected to open progressively during 1990/91.

FEATURES OF THE PLATFORM BUILD

The phased approach to implementation of the programme, whereby 'packages' of features are implemented progressively throughout the BT network, has been outlined above . The first of these packages, referred to as the *Platform* will be rolled out nationally from July 1990 onwards, after trials of its features conducted at the two pilot sites in Walsall and Manchester. Before the Platform can be implemented, a number of 'enablers' must also be in place, such as communication systems, personnel aspects, training, documentation etc. It is particularly important to ensure the availability of appropriate support systems, or computer tools, which are an essential prerequisite of most new methods of working.

The major impact of the Platform will be in the operations and support centre (OSC) area of the NOU. Here, the maintenance controls for the whole of the modern network, in the NOU catchment area, will be brought together into a single location. This will involve the local and trunk operations and maintenance units (OMUs), together with the trunk regional network management centre (RNMC). A number of network surveillance systems such as digital equipment alarms, transmission systems monitoring, and alarms for power and building engineering services, will be brought together. This will necessitate the provision of new sup-

port systems to enable the various monitoring facilities to be merged. One particular system is the network operations management system (NOMS) which will permit concentration of digital systems alarms onto a single screen, and facilitate access to remote administration tools. NOMS will also control tasks dealt with by the maintenance field force including out-of-hours activities. TXE4 exchanges form part of the modern network, and a range of facilities to allow their remote administration will be provided. A further significant aspect is the proposal to amalgamate trunk and local 24-hour staffing rotas. Technical support groups within the NOU catchment area will also be brought together under control of the NOU.

Outside the OSC area of the NOU, other features include the introduction of a 'standard practice' performance measurement system. This will be based on the measurement and analysis centre (MAC) and exchange performance information collection (EPIC) systems. There will also be functions to support the interface between the network and its customers, such as fault handling procedures, definition of performance levels and the establishment of procedures to allow effective use of line test systems by customer-facing staff. The customer-facing organisation will be supported by a 'help desk' contained within the NOU. A 'standard practice' procedure for network circuit provision activities has been determined by the Central Operations Unit and Plant Utilisation FWG and this will also be rolled out as part of the Platform.

CONCLUSION

This article has provided an overview of the Network Administration Implementation Programme to date. NAIP is a long-term programme aimed at exploiting the massive capital investment that BT has made in the network. NAIP will develop new administration systems and procedures, but its success will be critically dependent on establishing a new network culture based on excellence and on being right first time, every time. The network will continue to grow and meet customer demands for new products and services. The network administration system now being developed will continue to evolve along with it. Future articles will address specific aspects of the programme in more detail.

Biography

Alan Bealby has been very closely involved over the past ten years with modernising the network. Initially, he was responsible for digital exchange planning and provisioning, but, more recently, as General Manager, Network Operations and Support (NOS) Department, he has had responsibility for all network support and support systems. He graduated in Electrical Engineering at Edinburgh University and subsequently obtained an M.Sc. in Administrative Sciences at The City University, London. He is a Chartered Engineer and is President of the IBTE Associate Section.

Mondial DISC—British Telecom's Latest International Gateway

I. C. BUTCHER, A. P. POINTEER, K. N. PATEL, and G. S. JACKSON†

In June 1989, British Telecom formally commenced traffic handling on its newest international gateway switch at Mondial House in London. The switch, which is designated Mondial Digital International Switching Centre (DISC), is an AT&T 5ESS-PRX switch. This article provides an overview of the Mondial exchange and its peripheral systems and features.

INTRODUCTION

As part of its network modernisation plan, British Telecom is in the process of evolving its international gateway switching system from the analogue environment into the digital environment. To achieve accelerated modernisation, British Telecom placed contracts for two gateways: Kelvin and Mondial. The latter was awarded to AT&T Network Systems UK Ltd. (then known as AT&T Phillips Telecommunications UK Ltd.) and was for the AT&T 5ESS-PRX switching system.

Mondial DISC is intended as a digital replacement for the Mondial analogue international switching centre (AISC) which currently performs the role of switching to a significant number of intermediate and minor route international destinations. Because of the important and complex function that Mondial AISC (and now the DISC) performs in linking the UK with many other parts of the world, it is essential that the Mondial DISC demonstrates reliability and provides powerful maintenance features.

The contract is for a two phase installation of 7500 erlangs each; Phase 1 in June 1989 and Phase 2 in 1991.

It is BT's strategy to evolve a network of UK international gateways by the early-1990s whereby all BT DISCs are fully interconnected to each other, and each of these gateways will handle a mixture of major, intermediate and minor-sized international routes. This will ensure resilience to failure of any one DISC which might otherwise cause temporary loss of service to or from a particular destination. Additionally, each gateway will require full interconnection with the BT UK network to minimise congestion due to temporary loss of one of the gateway switches.

An overview of Mondial DISC follows.

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A Glossary of Terms used in this article is given as an Appendix

5ESS-PRX SWITCH AND PERIPHERAL SYSTEM HARDWARE ARCHITECTURE

The 5ESS-PRX is a time-space-time (T-S-T) switch and has a distributed modular architecture which enables the cost-effective addition of new features and hardware units. It is composed of an administrative module (AM), a communications module (CM), and a number of switching modules (SMs). Additionally, the installation includes peripheral equipment which provides for international accounting, traffic measurement and maintenance access to the switch. These are all shown in Figure 1.

The following sections describe in more detail the switch modules and peripheral systems and their interrelationships, as well as the human—machine interface of the switch.

Administrative Module (AM)

The administrative module (AM) provides the system level interfaces required to operate, administer, and maintain the 5ESS-PRX switch. The AM allocates global resources such as internal system time-slots, memory, data storage and global service circuits, and searches for an available trunk in a trunk group during call processing. It also controls provision of information on traffic measurements, collection of per-call records for accounting, programme updates, and database changes. The AM is also responsible for network control, and sending control messages to the communications module and switching modules, and it provides interfaces to operations and maintenance support systems such as the multifunction operations system (MFOS), master control centre (MCC), network management centre and service observation positions. Lastly, maintenance functions such as diagnostics, error detection, fault recovery and software initialisation are executed by the AM.

The AM comprises the following major components: an administrative processor (AP), disc storage, tape back-up, input/output controllers and peripheral controllers (PC) as shown in Figure 2.

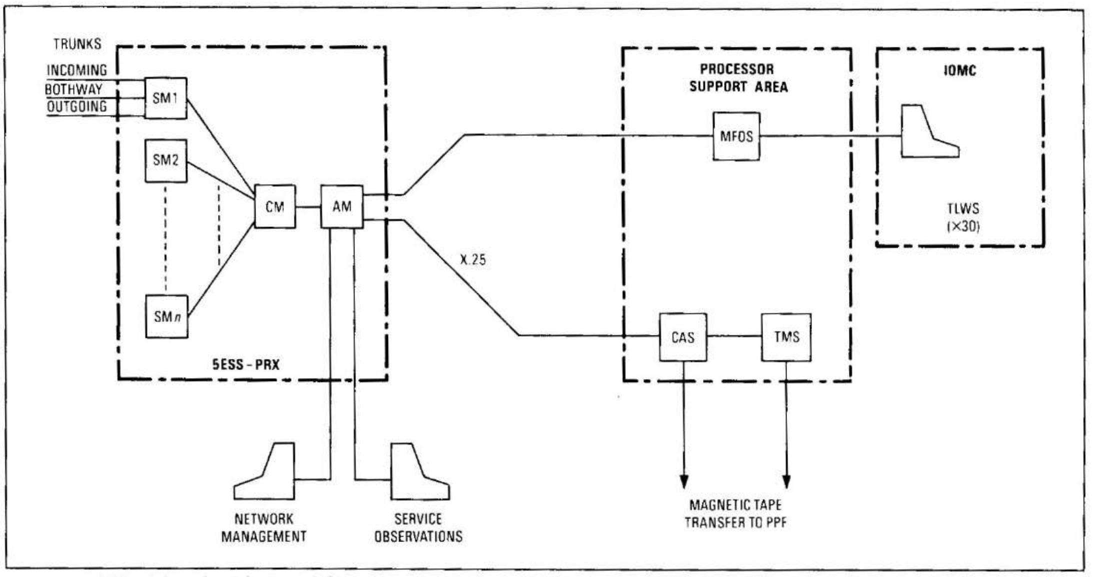


Figure 1
Mondial DISC overview

AM: Administrative module
CM: Communications module
CAS: Call accounting system
IOMC: International operations and maintenance centre
MFOS: Multifunction operations system
SM: Switching module
TMS: Traffic measurement system
TLWS: Trunk and line work station
PPF: Post processing facility

The administrative processor is an AT&T Technologies 3B20D (Duplex) computer, which is fully duplicated for reliability. The two processors work in an active/stand-by configuration with the stand-by processor's data continuously updated, thus allowing the stand-by to be switched into service with no data loss in the event of a failure in the active processor.

Communications Module (CM)

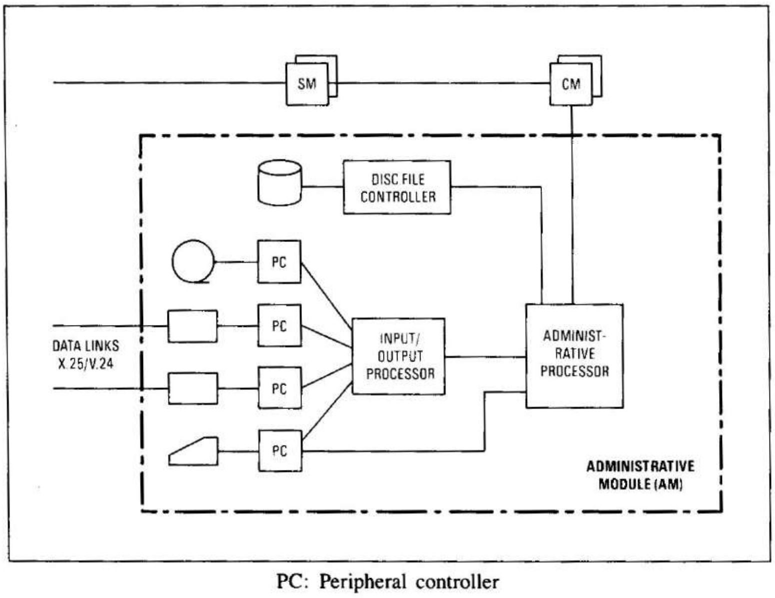
The communications module (CM) provides for the transfer of call processing and administrative messages between the AM and SMs and between two SMs involved in a call, and is the 'space' switcher of the T-S-T configuration.

The CM routes control messages to allow the SM processors to communicate with the AM processor. It also allows messages to be passed between SMs without passing through the AM processor.

Each SM is connected to the CM via network-control-and-timing links. Each network-control-and-timing link carries 256 time-slots between the SM and CM. Of the 256, one time-slot is dedicated to control-message use and the remaining 255 are available for data (voice) use. The CM also contains the network clock unit which provides master system timing and synchronisation for the 5ESS-PRX switch to the switch network. This high stability clock is duplicated.

Mondial DISC has a CM type 2 which can support, theoretically, up to 190 SMs, but will be equipped to handle 94 for the DISC application.

Figure 2
Administrative module



PC: Peripheral controller

Switching Modules (SMs)

Trunk circuits are connected to the 5ESS-PRX switch via the switching modules. These SMs convert signals received from the trunks to the internal digital format of the exchange. The software in the switching module (SM) performs up to 90% of the call processing functions in the exchange.

Global SMs

There are three SMs that perform a global function for common-channel signalling systems: CCITT No. 6, CCITT No. 7(TUP), C7(BT). The global SM handles the signalling data links for its respective common-channel signalling system and links back to each SM carrying voice trunks for that signalling system.

SYSTEM PARAMETERS

Termination Capacity

Mondial DISC will have 94 switching modules (SMs) equipped with 1440 digital facility interfaces (DFIs). The DFI is the AT&T equipment which terminates a 2 Mbit/s PCM system on an SM. Assuming 30 channels per DFI, this gives a total termination capacity of 43 200 connections at Phase 2.

Traffic and Call Capacity

The traffic (erlangs) capacity of the 5ESS-PRX switch is determined by the number of SMs installed. Each SM can handle approximately 460 erlangs (90% occupancy of time-slots), so the traffic capacity of the exchange is given by $460 \times n/2$ where n is the number of SMs. Thus the theoretical capacity of Mondial DISC with 94 SMs is 21 620 erlangs. However, not all SMs are equipped fully and the rated capacity of Mondial DISC is 15 000 erlangs.

The current capacity of the 5ESS-PRX switch (generic 5EE3.2), measured in busy hour calls (BHC), is 300 000 BHC for UK and international originating calls at Phase 1. This figure reflects the processing capacity of the AM. The capacity is also determined by the number of SMs installed. Each SM has a maximum call capacity of 10 000 BHC, but actual capacity depends upon the termination type; that is, CCITT R2D, CCITT No. 5, C7(BT) etc. At Phase 2, the BHC will be increased to 400 000, with 40% overload capacity.

SIGNALLING SYSTEMS

The following signalling systems will be supported by Mondial DISC (Figure 3):

LD/PCM
: Loop-disconnect signals are digitally represented in time-slot 16 (TS16) of a digital path. A multi-metering capability is also available if required. TS16 signals are detected/inserted by the signalling processor (SP) in the SM.

C7(BT)
: Common-Channel Signalling BT No. 7 will be used between digital main switching units (DMSUs) and Mondial DISC. The DMSUs will automatically re-route (ARR) traffic to the Mondial AISC on receipt of the congestion message. The ARR is sometimes referred to as *crank back*. Up to 52 signalling links will be supported during Phase 1 increasing to 90 in Phase 2 (generic 5EE4.2). Normally there will only be two links per link set. Mondial DISC will not act as a signalling transfer point for the national network.

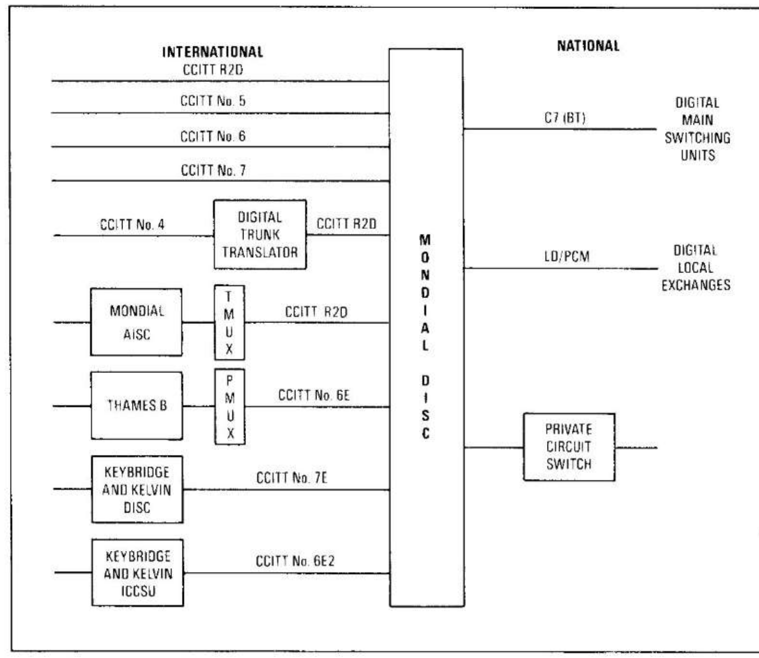


Figure 3
Mondial—signalling systems

CCITT No. 5
: Line signalling for CCITT No. 5 circuits will be detected/inserted at the interface unit (after the DFI) by the echo canceller signalling unit. Inter-register address signals are decoded/coded by a unit in the SM.

CCITT R2D
: Line signals for R2 circuits are encoded into TS16 of the digital path by the signalling processor in the SM. Inter-register signals are encoded/decoded by a unit in the SM. Conversion to R2 analogue circuit will be done off the switch with TMUX equipment located in an international repeater station or earth (satellite) station.

CCITT No. 6
: The signalling data link for CCITT No. 6 circuits is presented to the switch on a digital bearer. The signalling link is routed on a semi-permanent connection through an analogue trunk unit (digital-to-analogue, analogue-to-digital converter), a modem, and a data port before it terminates on a protocol handler.

CCITT No. 6E
: This system has additional signals for echo control and is used between international switching centres (ISCs).

CCITT No. 6E2
: This system has additional signals for echo control and accounting and is used between an ISC and an international call connect switching unit (ICCSU).

CCITT No. 7(TUP)
: CCITT No. 7(TUP) is to be provided at Mondial DISC.

CCITT No. 7E(TUP)

An enhanced version is provided for the inter-ISC ties. The enhancement provides for special messages to forward originating route indicators for the accounting function.

CCITT No. 4

CCITT No. 4 circuits are not supported by the 5ESS-PRX. CCITT No. 4 circuits will be presented to the switch as R2D circuits after the signalling protocols have been converted by digital trunk translators provided by Delta Communications.

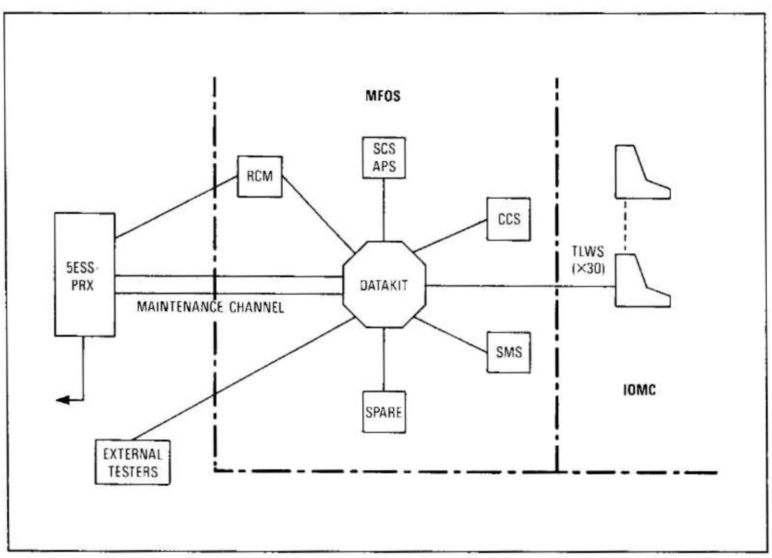
TCC

Through connect circuits (TCC) for connection to a private circuit switch. If a private circuit is included in a 2 Mbit/s system connected to the 5ESS-PRX, then it is *nailed up* to the TCC. This gives a permanent connection for the private circuit.

ECHO CANCELLERS

Mondial DISC will employ echo cancellers. These will be provided on a 2 Mbit/s path basis although control will be on a per-time-slot basis. The cancellers cater for a propagation path delay of up to 64 ms. The canceller is controlled on a per-call basis and includes the tone disabling feature. The echo canceller also includes a line signalling unit for CCITT No. 5 circuits. A separate rack of echo cancellers, independent from the switch, is being provided for international private leased circuits for Phase 1 as currently the integral cancellers will not remain in their previous mode, where this was the disabled mode, if an SM initialisation should occur. These 'stand alone' cancellers will be removed after Phase 2, when full echo control will be available.

Figure 4
Multifunction operations system



APS: Alarm processing subsystem
CCS: Common communications subsystem
SCS: System controller subsystem
SMS: Switch maintenance subsystem
RCM: Recent change module
TLWS: Trunk and line work station

THE HUMAN INTERFACE

Trunk and Line Work Stations (TLWS)

The main interface between the technicians and the 5ESS-PRX is through a trunk and line work station (TLWS). This comprises a colour VDT, a keyboard, a talk-and-monitor telephone and a set of associated test jacks. There are 30 TLWS provided in the Mondial international operations and maintenance centre (IOMC) and up to a maximum of 16 can interact simultaneously with the 5ESS-PRX at Phase 1. This simultaneous interaction will increase to a maximum of 32 TLWS at Phase 2.

MULTIFUNCTION OPERATIONS SYSTEM (MFOS)

Overview

The purpose of the MFOS is to connect the TLWS terminals located in the IOMC to the 5ESS-PRX and other maintenance facilities. The MFOS at Mondial contains a Datakit and six 3B2 processors. The arrangement is shown in Figure 4.

Datakit VCS 2000

Datakit VCS (virtual circuit switch) is used to connect terminals (TLWS), network elements, printers and display terminals using packet switching principles. This allows any terminal to be connected to any MFOS subsystem or network element.

Common Communications Subsystem (CCS)

The common communications subsystem (CCS) interfaces with the other subsystems to provide a common point for protocol conversion and data distribution to other MFOS subsystems.

System Controller Subsystem (SCS)

The system controller subsystem (SCS) interfaces with the other subsystems to provide a common point for MFOS maintenance and administration. The SCS provides common database administration and allocates overall network resources to ensure proper service while automatically maintaining system integrity.

Alarm Processing Subsystem (APS)

The alarm processing subsystem (APS) analyses and displays alarm conditions from the 5ESS-PRX and the other MFOS subsystems. It interfaces with the switch maintenance subsystem (SMS) to receive maintenance channel messages and alarms, and, with the CCS, to receive 5ESS-PRX status alarms. All alarms can be acknowledged by a user and this is indicated on the display.

Switch Maintenance Subsystem (SMS)

The SMS provides surveillance and control of the 5ESS-PRX. All messages and reports from the 5ESS-PRX are sent to the SMS, and the SMS examines and sorts them, so that they can be stored in the appropriate logging files. All alarm messages are sent to the APS. These files can then be searched or manipulated for selective pattern matching and sorting by IOMC staff. Because of the load at Mondial, the system comprises two 3B2 processors connected in load share mode.

Recent Change Module (RCM)

The recent change module (RCM) is used to interface to the 5ESS-PRX for manipulation of the DISC database. Access is obtained via the MFOS. The RCM is a processor system which generates the screen views for data modification and converts the screen data into commands for modifications to the switch office dependent data.

The consistency checks on the recent change and verify (RC/V) activity creates significant AM processor load. The response time to changes can be impaired during peak traffic periods. To reduce the impact of this, the RCM has been developed and installed. This is a 3B2 processor that off-loads the procedure that displays RC/V screen forms from the AM processor. This improves the throughput of data changes.

Maintenance Channel

The maintenance channel is used to transfer the messages and reports from the 5ESS-PRX to the SMS. It is also used for the TLWS terminal dialogue information and reports to and from the 5ESS-PRX. It comprises five X.25 data links.

CALL ACCOUNTING AND TRAFFIC MEASUREMENT SYSTEMS (CAS/TMS)

International Accounting

All telecommunications administrations must settle accounts with their partner administrations for use of their respective equipment for every call that has been completed. The unit of settlement is the *paid minute* obtained from call duration measurements. In the case of British Telecom, each British Telecom International ISC calculates and records the paid minute totals. The accumulated information is then forwarded to a mainframe post processing facility (PPF) computer which calculates and provides summary paid minute totals across all ISCs.

Call Accounting System (CAS)

Mondial DISC totals are calculated by using an off-line AT&T/Olivetti 3B15 minicomputer subsystem, the call accounting system (CAS).

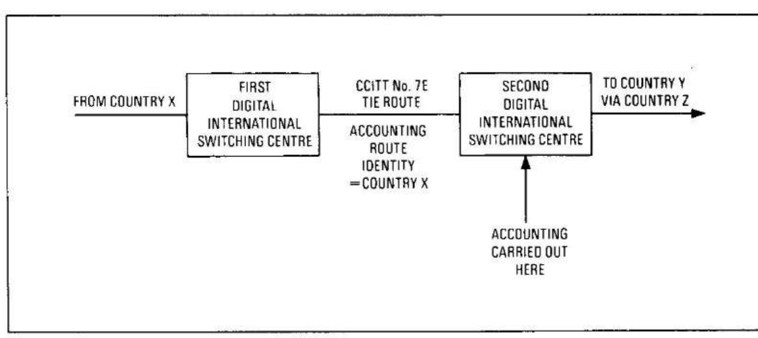
For every call arriving at the DISC, the incoming SM creates a per-call record, holding incoming and outgoing route information, call duration, and dialled digits. A record is created irrespective of whether the call attempt is successful. These records are passed to the AM and stored on duplicated 300 Mbyte hard discs. The CAS polls the AM during non-busy hour periods, and the raw records are passed over several X.25 links, where they are again stored on duplicated hard discs of the CAS.

Using its internal database, the CAS processes each record, translating it into a call duration and adding it to one of almost 750 000 unique 8 byte counters, each counter representing a combination of several overseas administrations from over 200 that BT deals with.

At midnight, a snapshot is taken of all counter values, written to magnetic tape and sent to the PPF. A high-speed datalink will later replace the magnetic tape transfer mechanism.

Mondial is the first DISC supporting the CCITT No. 7E(TUP) signalling system, to be used over inter-DISC tie routes. The enhancement forwards accounting route information from the first DISC to the second as shown in Figure 5.

Figure 5
Enhanced accounting system (second man accounting)



Using the accounting route information, the second DISC is able to identify the incoming administration identity. By combining this information with the outgoing route chosen and the actual dialled digits, complete and accurate accounting is performed. This concept is known as *second man accounting*.

Traffic Measurement

Traffic measurements applied on a circuit basis, destination basis and ISC basis, allow quality-of-service and network performance figures to be monitored, with corrective action taken if necessary. It has the added advantage of providing accurate traffic growth figures, helping planners forecast and procure additional line-plant and switching requirements in a cost efficient and timely manner.

Mondial DISC uses a second off-line AT&T/Olivetti 3B15 minicomputer subsystem, the traffic measurement system (TMS), to generate this data.

Traffic Measurement System (TMS)

Raw per-call records sent to the CAS from the AM are then duplicated and sent over a high-speed datalink to the TMS, where they are again secured on disc, prior to processing. Raw data is translated into incoming and outgoing trunk group information for up to 2000 routes, and 2500 national and international destinations, broken down on an hourly basis. Information includes erlangs, number of call attempts and number of answered calls, and is further broken down into a call type basis, including the identification of international direct dialling, operator-assisted and international calls transiting the UK to reach some other overseas destination.

The TMS will provide on request a traffic dispersion breakdown of calls to each of the 2500 national and international destinations, on up to eight incoming routes per hour for route performance summaries.

At midnight, as with the CAS, a snapshot is taken of all several million TMS counter values, written on magnetic tape and sent to the PPF, where, together with similar data from the other ISCs, the summary information is further processed to produce the required statistics by 9.00 hours that morning.

NETWORK MANAGEMENT

An essential feature of any DISC is having the facility to monitor its performance and its impact/influence on the network in as near to real time as is possible. Having established the performance status during periods of high stress on the network (for example, an undersea cable failure or a national disaster), it is then essential that those responsible for safeguarding the network can take prompt and effective action to ensure that the performance of the network is protected and maintained at the optimum level.

The Mondial DISC network management facilities are provided in two parts to coincide with the two contract phases.

Phase 1 Controls

Phase 1 provision includes the collection of basic data to enable the detection of overload or partial network failure and protective or expansive controls to ensure that the network operates at the optimum level possible commensurate with the type and degree of failure.

The controls available are a mix of automatic and manually applied measures which will depend upon the circumstances prevailing.

Overload conditions may be caused by one or more of the following factors:

(*a*) major problems within a switch due to hardware or software failures,

(*b*) mass calling by the public due to major events such as fires or other disasters,

(*c*) partial failures of the network, and

(*d*) unexpected high additional call levels at an existing peak period.

Having established that overload exists, personnel in the international network management centre (INMC) can elect to apply manual controls which can:

(*a*) restrict traffic access to selected routes,

(*b*) expand route choices,

(*c*) regulate the rate at which calls are released towards a specific destination, and

(*d*) remove the automatic controls applied by the switch.

Under certain circumstances, the Mondial switch will apply selective incoming load control which will regulate the percentage of traffic from selected incoming routes.

Phase 2 Controls

Phase 2 will bring enhanced controls which will enable the INMC:

(*a*) to restrict the percentage of traffic offered to 'hard-to-reach' destinations which are those where for various reasons the number of calls answered is very low (The result if the control were not applied is that the switch could be forced to refuse calls which could complete while handling those that could not.);

(*b*) to utilise trunk reservation facilities; and

(*c*) to apply domain selectivity which allows particular controls to be applied to any combination of international, national and transit originating traffic.

The Mondial DISC will provide the facility for data to be transferred to an INMC in 30 second and 15 minute intervals which, along with similar inputs from other DISCs, will enable a complete picture of the network condition to be established.

Additionally, Phase 2 will bring enhancements to the data available to users remote from the switch.

SERVICE OBSERVATION

The service observation feature provides a means for monitoring individual calls, each selected on the basis of predefined criteria. Monitoring provides detailed information which may be used to assess the quality of service on particular facilities.

The system is operated from remote terminals working via data links. The system will monitor/record details of calls such as incoming and outgoing trunks, digits dialled and the reason the call failed, if any. A record is created for each call monitored which is held on disc at Mondial House. These records are transferred to magnetic tape at Mondial for processing at an off-line facility.

The system can be used to perform *automatic observations* (call monitoring in which the reason for call failure is inserted into the call record by the system) or *manual observations* (service assessment) in which the operator listens in to

the call and enters an assessment of it at the terminal.

Service observations are set by means of *programmes*. A programme is a set of parameters that define which calls are monitored. Up to eight monitoring programmes may be defined, each of which allows for the monitoring of a particular type; for example, incoming on a specific trunk group, outgoing to a specified destination, etc. A monitoring session may be performed completely automatically, or manually with intervention from an operator who listens in and assesses the quality of service on monitored calls. A report is generated for each monitored call and written to disc. A monitoring programme is terminated automatically after a predefined time, after a predefined number of calls have been monitored, or manually by a command entered by the operator.

OPERATIONS AND MAINTENANCE FACILITIES

Overview

The operations and maintenance capabilities of the 5ESS-PRX switch include the switch maintenance, circuit maintenance, routine reporting and data modification capabilities. Many of the features have been developed for a gateway exchange and BT in particular. All operations and maintenance tasks will be performed from a work station in the IOMC. Access to the 5ESS-PRX is obtained via the MFOS. Remote test equipment is also accessed from MFOS via the Datakit packet switch.

Switch Maintenance

Hardware and software error detectors, automatic fault recovery procedures and duplication of common units provide the 5ESS-PRX with the ability to locate and configure around faulty units without service interruption.

Software Error Detectors

The 5ESS-PRX is designed with fault tolerant software that enables it to detect errors before they adversely affect service. In-line defensive checks are inserted in the software code to detect errors at the interfaces of processes in order to detect faults at the earliest feasible time and signal for recovery.

An example of error correction is that, on reading data from the main store, the system can detect and correct any one bit error in each 32 bit word by use of a Hamming code parity byte stored along with the data at the time of writing.

Audit programmes are provided to detect, confine and correct data errors before they can propagate and lead to system outages. Action taken may be to stop and restart the software process concerned or stop a process and report the problem via the maintenance fault printer.

Hardware Trouble Detection

The 5ESS-PRX diagnostic system enables testing of an entire equipment unit, sub-unit or community. Diagnostics are initiated automatically via system recovery and routine exercises programmes or manually, by the technician, from a TLWS. A unit verified as faulty will remain out of service. The trouble-locating procedures within the diagnostic output messages enable technicians to replace equipment listed as 'suspected faulty'. Various diagnostic activities run concurrently on multiple processors without interfering with normal system activities.

Recovery

The 5ESS-PRX has extensive capabilities to recover from automatically detected problems with minimum impact upon the service to the customer. Most hardware is duplicated, allowing faulty equipment to be removed from service with its back-up hardware taking over. This switch-over can be performed automatically or by manual command. Software recovery forms a hierarchical structure, which, combined with the hardware design, allows initialisations, that is, software restarts, to be confined to the affected areas, with no or minimal impact upon the total switch. The 5ESS-PRX can reinitialise individual SMs in approximately two and a half minutes, or the entire switch in several hours.

When any part of the switch is restarted, a printed message is generated giving detailed data related to the problem, which enables the maintenance personnel to identify the cause and take corrective action to prevent further occurrence.

Repair

When an output message indicates that a particular unit is faulty, a diagnostic process can be run and this includes a trouble-locating procedure. This provides the maintenance personnel with the location of suspected faulty circuit packs. Faulty circuit packs are automatically removed from service for subsequent repair. Circuit packs are then returned to AT&T for repair.

Trunk Testing

Trunk testing is fully integrated into the switch under control of the terminal maintenance software. Maintenance personnel using the TLWS seize one of 16 test positions. This software entity allows maintenance personnel to interactively seize and test trunks. Maintenance personnel can seize a trunk, monitor speech, perform transmission tests and send test calls. The maintenance personnel can connect the trunk under test to AC jacks for connection of external test equipment. The TLWS software does not support frequency measurements. Such tests would require external test equipment attached to the AC jacks. Test calls will allow terminal/transit indicators and discriminating digits to be varied; a development specifically requested for Mondial DISC.

Signalling Checks

Circuit Monitoring

The 5ESS-PRX circuit monitoring feature provides the maintenance personnel with the ability to monitor signalling information on a specified trunk or trunk group. The monitor works on a per-call basis, and at the end of the test session displays all the sent and received signals. It will not be possible to measure the duration of signals. Signals within specification are displayed in order of receipt. Circuit monitoring supports up to 16 users. All signalling system types can be monitored.

Common-Channel Signalling—Signalling Data Links

Monitoring of signals on the signalling data links associated with CCITT No. 7 and CCITT No. 6 routes is achieved by external testers. A personal computer is used to monitor signalling data links for CCITT No. 6 links. Test access to a link is possible in the IOMC via a jack panel. CCITT No. 7 signalling links can be accessed at the DDF 2 Mbit/s monitor point using specialised test equipment which can be command controlled from terminals in the IOMC.

Monitoring Analogue Trunks

Any trunk can be monitored using a TLWS test position and the talk-and-monitor telephone, which can be inserted or removed from the circuit under test by command. Additionally, the trunk can be connected to the AC jacks for connection of external test equipment. It will not be possible to monitor line signals for CCITT No. 5 or R2D using the AC jacks since these signals are inserted/stripped-off before the monitor point. Integral switch facilities are provided for monitoring line signals.

Trunk Error Analysis

The 5ESS-PRX switch continuously monitors all trunks in all engineering routes to detect irregularities in signalling between Mondial and other connected switches (known as *interoffice*). Failures generate a machine-detected interoffice irregularity report (MDII). The MDII details the failure type, trunk, hardware used, signalling type, digits received or outpulsed and date/time. The MDII data is stored on disc files. The trunk error analysis is a software process that operates on the MDII failures and reports trunks with an abnormally high failure rate. If a trunk fails the trunk error analysis, recovery action can be ordered. Recovery actions can be to run an automatic test, to take the trunk out of service, to report the failure or to do nothing. Selected trunk groups (up to 20) can be specified for a more detailed study. MDII activity for trunk groups under study will then be summarised in a 24 hour plant report.

Automatic Trunk testing

The 5ESS-PRX supports automatic transmission measuring equipment and simplified R2 testing. Test responder equipment is provided to the CCITT Recommendation O.11; that is, reference tone, loop around test lines, quiet terminations and exchange test numbers. The national network will have access to trunk and junction routiner (TJR) responders and exchange test numbers. TJR director equipment will not be available until Phase 2. Test sessions can be scheduled using the integrated automatic trunk test scheduler.

Master Control Centre (MCC)

In addition to the TLWS terminals, a special terminal is provided close to the AM processor known as the *master control centre*. This comprises a VDT, keyboard and a read-only printer. Should communication from all of the TLWSs fail, then it is possible to access the AM processor directly and control recovery action via the MCC emergency action interface. This interface is duplicated on the switch and driven by specialised firmware that ensures communication is still possible if the switch loses sanity. The MCC is used to set up parameters required in a full initialisation.

There is also the facility for AT&T to remotely access the switch as an MCC to obtain data to enable rapid support and diagnosis of problems which on-site personnel cannot solve. This access is via a modem and password system and requires the agreement of BT before it can be used.

Data Modification

All circuit, trunk group, digit and routing analysis information is held on a database known as *office dependent data*. The data is modified by the use of the recent change and verify (RC/V) feature. The RC/V feature is menu driven and the data is presented on a TLWS screen as a form or group of forms. The user enters key data in selected fields and can choose to change other data fields or allow the default values. Checks are made on the data inserted on the form in three ways. The first check is that the data is within the range (domain) allowed for a particular entry, the second that the data is consistent with other entries within the form, and the third check is for consistency with entries on other forms. Recent data changes can be removed (backed out) if found to be incorrect. The capability to create large amounts of changes as batch files of data changes (forms) and time-release them into the system also exists. The data modifications are done on a copy of the database relations, and when the current data is not being used by another process the new data is substituted.

Back-ups

The office dependent data is distributed throughout the AM and SM processor and is held in main memory. All recent change data is also held on disc in a temporary file. At scheduled intervals the data held in the AM/SMs is down loaded to disc files for security. It is also necessary to reorganise the hash relations of the database at regular intervals to ensure that fast data search times are maintained.

CONCLUSIONS

The 5ESS-PRX and related peripheral systems at Mondial House have undergone considerable development to cater for the unique requirements resulting in a flexible gateway switch. This development process is continuing with new and enhanced features in Phase 2 and includes upgrades to CAS/TMS, network management and MFOS.

The Mondial DISC, which is now in service, demonstrates the commitment of BT to modernisation and improved service quality to its customers.

Biographies

Ian Butcher is a manager in BTI's Implementation and Design Division and is responsible for aspects of the Mondial DISC technical support such as CAS/TMS, routing and some database functions. He has worked in BTI on transmission planning and works, as a DISC Unit Manager and Project Leader before moving to Mondial DISC technical support. He is an Incorporated Engineer (M.I.Elec.I.E.) and holds a Diploma in Management Studies (DMS).

Andy Pointeer is currently a manager responsible for operation and maintenance technical support for the Mondial DISC. Formerly, he performed clerk of works, installation and maintenance duties for an international crossbar gateway. In 1978, he successfully undertook acceptance testing on the Zambia international gateway. He has an ONC in Electrical and Mechanical Engineering and is trained as a system specialist on the 5ESS-PRX.

Kish Patel holds a B.Sc. in Electronics, which he obtained in 1975. He joined BT in 1981 after working for five years on hardware maintenance of printed circuit boards using TTL and CMOS technology. He spent five years on project management of major international telephone switching projects. He has been involved with major systems development support for Mondial DISC with specific responsibility for MFOS for the last three years.

Gordon Jackson joined BT two years ago after graduating from Napier Polytechnic, Edinburgh, with an Honours Degree in Communication and Electronic Engineering. He is currently responsible for the Mondial DISC CAS/TMS feature development, working in BTI's Implementation and Design Division. He is an Associate Member of the IEE, and is currently studying for an MBA.

APPENDIX

Glossary of Terms

AISC	Analogue international switching centre
AM	Administrative module
APS	Alarm processing subsystem
BHC	Busy hour calls
CAS	Call accounting system
CCS	Common communications subsystem
CM	Communications module
DISC	Digital international switching centre
DFI	Digital facility interface
ICCSU	International call connect switching unit
INMC	International network management centre
IOMC	International operations and maintenance centre
ISC	International switching centre
MCC	Master control centre
MDII	Machine detected interoffice irregularity
MFOS	Multifunction operations system
PPF	Post processing facility
RCM	Recent change module
RC/V	Recent change and verify
SCS	System controller subsystem
SM	Switching module
SMS	Switch maintenance subsystem
TLWS	Trunk and line work station
TMS	Traffic measurement system
TUP	Telephony user part

Numbering in Telecommunications

N. A. C. McLEOD†

This article reviews the application of numbering in telecommunications networks, considering in particular the influences on the evolution of the numbering plan for the switched telephony services.

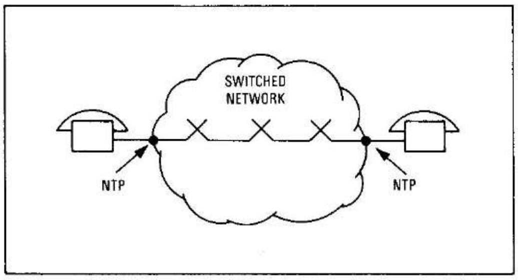
INTRODUCTION

The regulatory environment for telecommunications in the UK has focussed attention on numbering since there is a requirement to ensure the availability of numbers for allocation to all public telecommunications operators (PTOs) and service providers. This article takes a brief look at the numbering schemes used in public switched networks and considers in particular the developments in the use of the numbering plan for switched telephony services.

General Principles of Numbering

Numbering schemes are an essential part of the infrastructure for providing services over switched telecommunications networks. The primary function of a number as originally conceived was to identify the network terminating point (NTP) through which a customer received service (see Figure 1).

Figure 1
The network and the network terminating point



NTP: Network terminating point

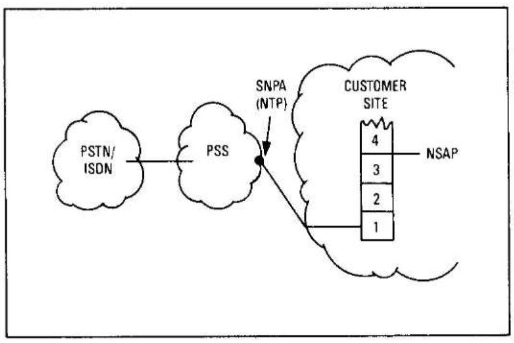
The numbering schemes were also designed to assist in the selection of the path from the point of origin of the call to its destination. This is the fundamental basis of the design of the separate numbering plans that exist for the telephone, Telex and data networks. The developments in technology and the emergence of new services, including the integrated services digital network (ISDN) and those involving mobility, require a rethink in the way numbering is considered. For instance, with ISDN being the vehicle for the support of a variety of services that were previously the province of dedicated networks, there is a need for universal numbering arrangements for telecommunications that allow full interconnectivity of services and networks.

INTERNATIONAL STANDARDS FOR NUMBERING

Conformance with agreed international standards is a prerequisite for full global interconnectivity. A variety of such standards now exists covering telephone networks, data networks, Telex networks and mobile networks. The standards for mobile networks include both maritime and land mobile applications and are derived from those for the telephone and data networks. These standards are defined in the recommendations of the CCITT, and are listed in the bibliography at the end of this article.

Another, more recent, area of standardisation has been that of naming and addressing for Open Systems Interconnection (OSI) where a global scheme for the identification of network service access points (NSAPs), the interface between Layer 3 (Network) and Layer 4 (Transport) of the OSI 7-layer model, has been developed by the International Standards Organisation (ISO).

The main difference between the approaches of the two international bodies is that the ISO work has been driven by the need for an addressing scheme that was independent of network types or routing requirements. In the OSI global network, the NSAP resides in the customer end system, and the physical networks through which end-to-end connection is achieved are considered to be sub-networks. The relationship is shown in Figure 2. Such addressing schemes are not considered further in this article.



SNPA: Sub-network point of attachment
NSAP: Network service access point
Figure 2—The OSI global network

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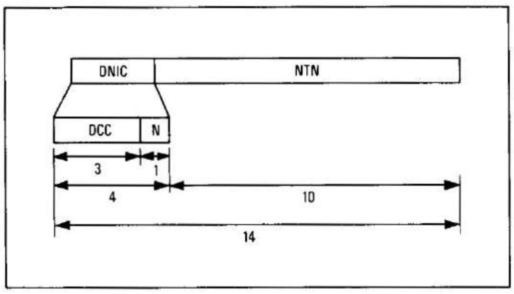
At present, most attention is being focussed on the numbering plans for data and telephone networks. Each of these international numbering plans and their application in the UK is described in the following paragraphs and areas of likely change are identified.

DATA NETWORK NUMBERING PLAN

The numbering plan for public switched data networks and services is described in CCITT Recommendation X.121 (Figure 3).



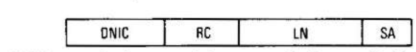
DCC: Data country code
N: Network digit
DNIC: Data network identification code
NTN: Network terminal number

Figure 3—X.121 number structure

An international data network number comprises two parts, the data network identification code (DNIC) of 4 digits and the network terminal number (NTN) of 10 digits. The DNIC is itself made up of two elements, the data country code (DCC) of 3 digits and a network digit. By this means, up to 10 data networks can be supported by a single country code. The structure of the NTN is a matter for the network operator to whom the DNIC has been allocated, the routing of calls between networks requiring only the analysis of the DNIC. In drawing up the plan, the CCITT made provision for more than one DCC to be allocated to a country. Initially, the DCC 234 was allocated to the UK; more recently, 235, 236 and 237 have been added to the UK allocation allowing for a total of 40 DNICs.

In addition to its primary use for routing calls, the DNIC has become important in the management of data networks and services providing a unique identifier for such features as call routing records, closed user group (CUG) interlock codes and transit network selection.

An example of the way in which the NTN can be used is seen in the BT Packet SwitchStream (PSS) service which operates under the DNIC 2342 (Figure 4).



RC: Routing code
LN: Local number
SA: Sub-address

Figure 4—BT PSS network user address structure

For packet switched networks, the customer/network interface standard X.25 refers to the X.121 data network number as the *network user address* (NUA) and recommends that the last 2 digits of the NTN should be reserved as a sub-address for use within the customer's end system. In the BT application of X.25, the remainder of the NTN has been divided into a 3-digit routing code to identify the packet switched exchange and 5-digit local number to identify the network terminating point serving the customer. When this structure was devised, the numerical values of the 3-digit routing codes were matched to the equivalent location codes in the PSTN. In practice, rigid adherence to this correlation has been found to be unnecessary.

With the introduction of competition in the provision and operation of data networks and services in the UK, the Office of Telecommunications (OFTEL) assumed control of the allocation of DNICs.

NUMBERING PLAN FOR THE TELEPHONE NETWORK

The original numbering plan for the international telephone network is described in CCITT Recommendation E.163 (Figure 5). Unlike that for data networks, the telephone numbering plan had to take account of the national arrangements that had already been developed throughout the world.

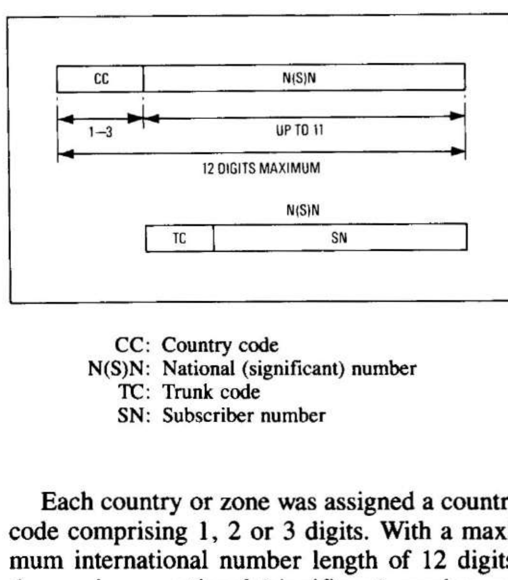


Figure 5 E.163 number structure

CC: Country code
N(S)N: National (significant) number
TC: Trunk code
SN: Subscriber number

Each country or zone was assigned a country code comprising 1, 2 or 3 digits. With a maximum international number length of 12 digits, the maximum national (significant) number can range in length from 9 to 11 digits. Both the international number and the national (significant) number exclude dialling plan prefixes such as the digit '0' for national dialling and '010' for international dialling.

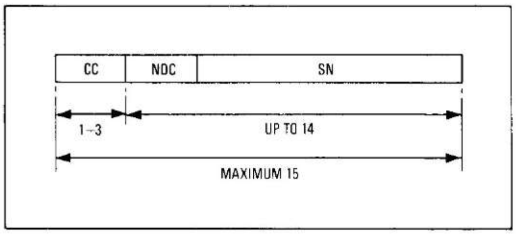
This plan served until the early-1980s, when consideration was being given to the numbering arrangements for the ISDN. It was recognised that the ISDN would evolve from the PSTN and, accordingly, its numbering requirements should be met from adaptation of the PSTN numbering plan.

NUMBERING PLAN FOR THE ISDN ERA

In 1984, CCITT Recommendation E.164 was approved as the numbering plan for the ISDN era. The provisions of E.164 subsume those of E.163 but do not impose any requirement for change to existing national numbering plans.

The main principles of the E.163 recommendation, such as the country code structure with one code per country and the provision for local, national and international dialling, were retained. The major changes were the increase in the permitted maximum international number length to 15 digits and the introduction of the *network destination code* (NDC) concept to embrace the E.163 trunk code and provide for other network and service identification functions within national numbering plans (Figure 6). In this respect, the NDC does no more than recognise the existing situation where codes from the trunk code series are used to identify mobile networks and special services such as Freephone and other non-geographic applications. Another significant difference between E.163 and E.164 lies in the number of digits that may be analysed to determine the international route. In addition to the country code, E.163 permitted analysis of up to 2 digits of the national number for this purpose, giving a variable maximum number analysis ranging from 3 to 5 digits (dependent on the length of the country code). In E.164 this has been changed to a fixed maximum of 6 digits including country code.

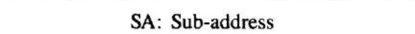
Figure 6
E.164 number structure



CC: Country code
NDC: Network destination code
SN: Subscriber number

Other provisions such as that of sub-addressing (see Figure 7) are yet to be fully developed. Sub-addressing is a facility whereby additional digits can be sent after the PSTN/ISDN number and conveyed across the public network/private network interface to provide a selection capability in the end system.

The sub-address field can typically range in length from 4 to 10 digits for 'simple' applications through to 40 digits to convey an OSI global NSAP address referred to earlier. The main issues yet to be resolved in CCITT are those of user procedures.



SA: Sub-address

Figure 7—E.164 number with sub-address

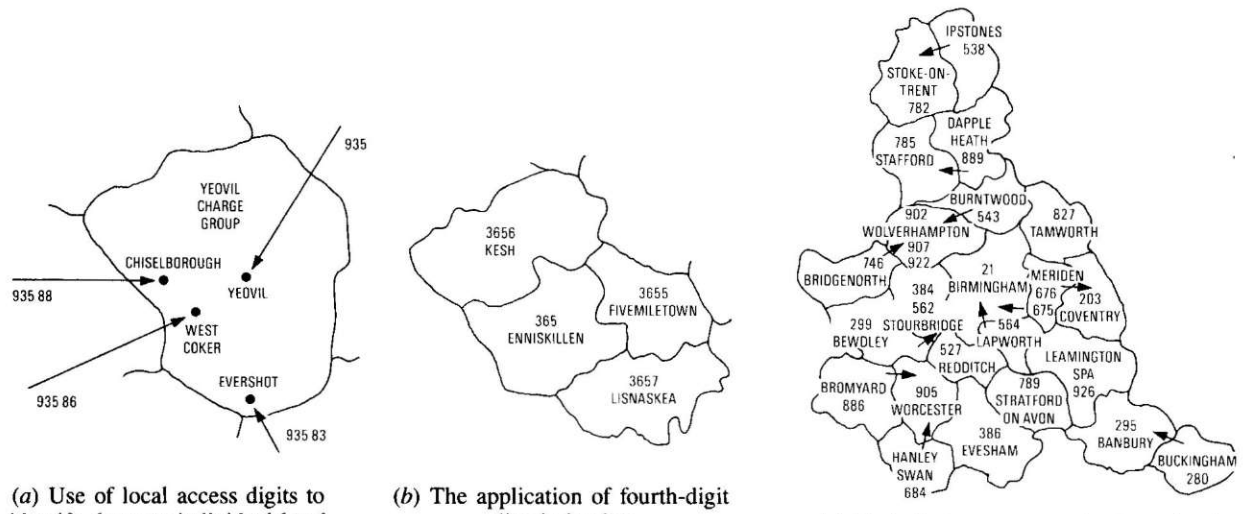
E.164 is often, mistakenly, seen as providing numbering arrangements for ISDN that are different from those for PSTN. In practice, ISDN access will, in most implementations, be indistinguishable from PSTN (analogue) access, residing on the same switch and sharing the same numbering range. The clue to the real power of this numbering plan lies in its title 'The Numbering Plan For The ISDN Era'. By design, E.164 is capable of exploitation for all types of service and network application providing a universal numbering umbrella allowing full interconnectivity both nationally and internationally. The scope for this exploitation can, however, be constrained by the historical numbering arrangements within a country.

While the need for the increased provisions of E.164 was recognised and accepted, it was also recognised that the early imposition of these requirements would place a considerable burden of change on the predominantly analogue switched national networks and international gateway exchanges to be found in most countries. As a consequence of these concerns, the CCITT took the unusual step of publishing a Recommendation, E.165, which details the arrangements for the full implementation of E.164 and specifies a date, 31 December 1996, for bringing the recommendation into effect. By this date, the introduction of digital switching is expected to be well advanced in all countries and the necessary enhancements to handle 15-digit international numbers and the increased number analysis for international routing available from the modernised networks.

UK PSTN/ISDN NATIONAL NUMBERING PLAN

The UK PSTN national numbering plan was devised in the late-1950s for the introduction of subscriber trunk dialling, its implementation predating the finalisation of the CCITT Recommendation for international numbering. The original scheme was based on a maximum number length of 9 digits, sufficiently long to encompass the then existing local numbering arrangements, but as short as possible to minimise the difficulties customers might experience in using such numbers.

As part of the plan for subscriber trunk dialling, a new charging arrangement had been developed using the *group charging* principle. The country was divided into some 638 charge groups each containing several local exchange areas. A national coding scheme using 3-digit codes as its basis was devised to identify individual charge groups or numbering areas within charge groups. These 3-digit codes were called national number group (NNG) codes and were initially made up of letters and numbers, the letters being derived from the place name or exchange name. In some cases, for example, rural areas served by UAXs, it was necessary to give each local exchange a national identity by



(*a*) Use of local access digits to identify down to individual local exchanges

(*b*) The application of fourth-digit discrimination

(*c*) Typical charge group structure showing numbering area codes

Note: Codes are shown in the later all-figure format and are preceded by the prefix '0' to form the national dialling code

Figure 8
Charge group numbering schemes

supplementing the NNG code with one or two local access digits (Figure 8(*a*)). In another variation, initially used in Northern Ireland, the 3-digit NNG code was shared by two or more charge groups, the fourth digit being used to discriminate between charge groups (Figure 8(*b*)). This was satisfactory for local numbers up to 6 digits in length, but for the director areas which had 7 digit local numbers the charge group/numbering area identification could not be more than 2 digits to fit in with the 9-digit maximum national number length. Since director areas used letters for the exchange code element of the local number, their charge group codes were presented in numerical form: 21, 31 etc. for the provinces and the digit 1 for the London director area. Adding the national *dialling prefix* '0' to these various numbering area code structures created national dialling codes which ranged in length from 2 to 6 digits. Figure 8(c) shows an example of the allocation of numbering area codes to charge groups.

The now familiar all-figure form of national number (see Figure 9) was established in the late-1960s, when the letters were replaced by numbers to comply with the requirements for international dialling. At the same time, codes with initial digit '0' were taken out of general use to overcome the possibility of confusion on international calls incoming to the UK where it was necessary to omit the national dialling prefix '0'. Apart from this, most of the changes to the numbering scheme have been within local areas, usually associated with planning for growth and exchange replacement.

The UK numbering scheme complies with the CCITT Recommendations E.163/164 in most respects, the 2-digit country code together with 9-digit national number being one digit short of the permitted maximum international number length (Figure 10).

The most significant departure from the international standard is the use of '010' as the international dialling prefix instead of the recommended '00'.

NATIONAL DIALLING PREFIX	NUMBERING AREA CODE	LOCAL NUMBER
0	ABC	DEFGHJ
NATIONAL DIALLING CODE		

For example: Leeds (0532) DEFGHJ
Birmingham 021-CDE FGHJ
London 01-BCD EFGH

Note: The C or BC digits are part of the 7-digit local numbers

Figure 9—UK PSTN numbering scheme

CC	NSN
44	ABC DEFGHJ

Figure 10—International number

Dialling Procedures

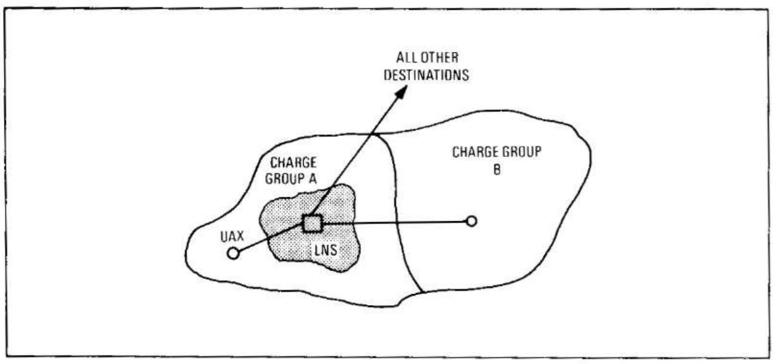
The dialling procedure (sometimes known as the *dialling plan*) for making calls on the PSTN currently has three levels, local number dialling, local code dialling and national number dialling. There are two types of local code dialling, the first is used within charge groups which have more than one numbering scheme and the second between adjacent charge groups (that is, within the local call charge area).

The main application of the first type of local code dialling occurs where a linked numbering scheme (LNS) and self-contained numbering

schemes co-exist in a charge group. In a linked numbering scheme, a number of exchanges share the numbering range in a way which allows calls between them to be set up using only the local number. Originally, linked numbering schemes were used in major urban areas which were served by a main exchange in the centre and satellite exchanges on the periphery. Small rural and remote non-director (RND) exchanges have self-contained numbering schemes where local number dialling is only available for own-exchange calls; access to other exchanges requires the use of additional local codes. Each rural or RND exchange has its own series of local codes whereas the LNS has a single series of local codes common to all the exchanges that it encompasses.

Local code access to adjacent charge groups is usually provided through the LNS main exchange acting for remote and rural exchanges as a local tandem exchange. This form of access gives customers, in most cases, a short code alternative to national number dialling for calls that are charged at local call rate. In the predominantly step-by-step analogue network, local code dialling to adjacent charge groups also had the benefit of reducing the requirement for expensive register translators and line relay-sets. (See Figure 11.)

Figure 11—Dialling procedures



Notes:

(*a*) Within LNS—local number only; for example, (DEFGHJ).
(*b*) LNS to UAX—local code + local number; for example, (85 + 234).
(*c*) LNS to charge group (CG) B—local code + local number; for example, (91 + DEFGHJ).
(*d*) LNS to other CGs—national number; for example (0ABC DEFGHJ).
(*e*) UAX own exchange—local number; for example, (234).
(*f*) UAX to other UAX—local code + local number; for example (986 345).
(*g*) UAX to LNS—9 + local number (9 + DEFGHJ).
(*h*) UAX to CG B—local code + local number (991 + DEFGHJ).
(*i*) UAX to all other CGs—national number (0ABC DEFGHJ).

DEVELOPMENTS IN THE USE OF PSTN NUMBERING PLAN

In the 30 years of its existence, the PSTN national numbering plan has seen remarkably little change, but, with the advances in technology and the emergence of new services in a liberalised telecommunications environment, it is not now expected to achieve its predicted lifespan of some 50 years. The way each element of the numbering plan is likely to be affected together with some international standards considerations is discussed in the following paragraphs.

Local Numbering

In addition to the traditional need for numbers to meet growth in demand for basic telephone service, there has been an increasing requirement for direct dialling in (DDI) to PBX extensions. ISDN will also have some impact on the demand for local numbers since it may be necessary to allocate up to 8 numbers to a basic access. This capability, called *multiple subscriber number* (MSN), is the only selection method presently available that will ensure full international access to terminals connected to an ISDN passive bus. In the longer term, it is intended that sub-addressing should be used for providing this selection function.

This increasing demand, coupled with the numbering requirements of other PTOs, in the first instance Mercury Communications Ltd., has led to the need to expand the numbering capacity in the London charge group by creating two numbering areas as described in a previous article†. Similar action may be required in a few other local numbering areas by the end of the century, but, for the most part, local numbering schemes will have adequate capacity as they evolve towards 6-digit local numbering with modernisation. The long-term objective is to have a fixed national number length within which the local number will be 6 digits or 7 digits depending on the type of local numbering area.

Local Code Dialling

The value of local code dialling has diminished over the years. From the customers' point of view, their increased mobility has made them aware of the inconsistency of the local codes, the code required to reach any destination being dependent on the exchange of origin in many cases. This has made the numbering plan appear unnecessarily complex and has become confusing in use. From the network aspect, the replacement of step-by-step exchanges by crossbar, electronic and now digital common control has reduced the economic advantage that was derived from local code dialling. Local code dialling to adjacent charge groups is therefore being eliminated as modernisation progresses. Local code dialling within a charge group is also gradually disappearing as the rural and RND exchanges are replaced and the areas they serve are integrated into the linked numbering scheme. The ultimate objective is to have only two dialling procedures, local number dialling with-

† BANERJEE, U., RABINDRAKUMAR, K., and SZCZECH, B. J. London Code Change. *Br. Telecommun. Eng.*, Oct. 1989, **8**, p. 134.

in a linked numbering scheme and national number dialling to all other destinations (Figure 12).

National Numbering

Since the inception of the national numbering scheme, NNG codes have been in short supply and their allocation subject to rigid control. In recent years, an increasing number of services which operate outside the geographic confines of the existing PSTN have emerged. These services fall into two categories, mobile communications and information services, and are distinguished by the allocation of all or part of an NNG code. It is in the area of non-geographic numbering that the greatest growth is anticipated, with 'personal communications' being widely predicted as the way to the future.

The present national code structure is recognised as being inadequate to meet the needs of telecommunications into the 21st century and a range of options for the development of the numbering plan has therefore been under study. Consultation is now taking place, through the Telecommunications Numbering and Addressing Board, on proposals to increase the national significant number length to 10 digits in order to accommodate these new demands.

International Dialling Prefix

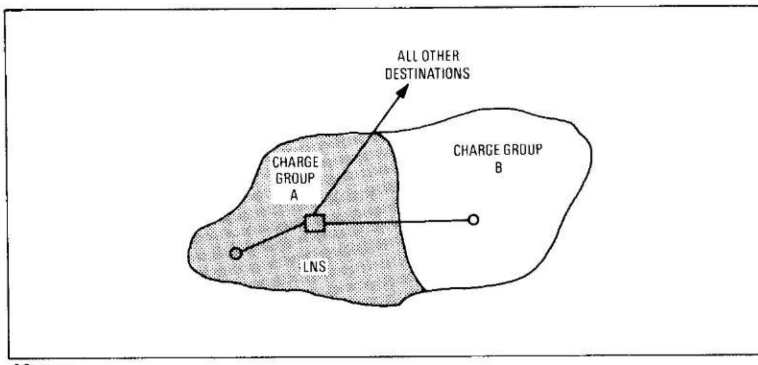
As mentioned earlier, the use of the digits '010' as the international dialling prefix within the UK does not conform with the CCITT recommendation. It is generally accepted that countries which have not yet adopted the preferred prefix of '00' will move towards it as they make changes to their numbering plan. For BT, the early adoption of '00' was largely ruled out by the cost of adapting the register translators in the analogue switched network. As this was the case, the use of NNG codes with the A digit value of '0' for services that did not require to be accessed from other countries, for example, 072 for the early radiopaging service, or where a short-term allocation was required, was considered to be a useful expedient that assisted in the conservation of the 'main stream' codes. It has, however, always been recognised that the UK would wish to conform with the standard at some time and the way should not be blocked by the excessive use of '0' series NNGs.

Modernisation of the network with digital switching systems has eased the technical problems, and this, together with the possible major change to the numbering plan, could pave the way for the introduction of '00' as the international dialling prefix.

Interworking Between Numbering Plans

At the present time, interworking between networks which use different numbering plans, for example, from the PSTN (E.163/164) to BT PSS (X.121), is achieved by two-stage call set up (see Figure 13). A packet assembler/disassembler (PAD) is the interworking unit that provides the interface between networks. The PAD is accessed from the PSTN using a PSTN number. The caller then inserts the PSS network user address of the required terminal to enable the call to be routed to its destination over the PSS.

In this arrangement, call set up can only be made in one direction, PSTN to PSS. For ISDN interworking with PSS, there is a requirement for call set up to be possible from both directions, since ISDN will be able to support data services to the same level of functionality as a dedicated data network. In this situation, a single stage selection process is preferred, the development of an internationally agreed method being an important aspect of the current studies on numbering in CCITT Study Groups II and VII.



Notes:

(*a*) Within CG A—local number (DEFGHJ).
(*b*) To CG B and all other CGs—national number (0ABC DEFGHJ).

Figure 12—Two-tier dialling

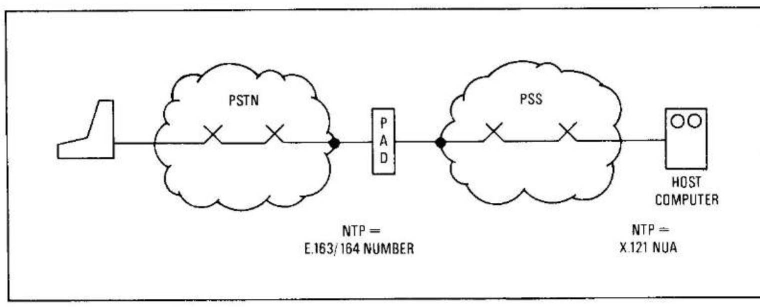


Figure 13 Interworking using two-stage call set up

CONCLUSION

Numbering for telecommunications is now subject to considerable interest, both nationally and internationally. While numbering plans generally have a theoretically large capacity, the imposition of hierarchical structures based on geographic distribution significantly reduces the efficiency of their utilistation. The increase in demand for numbering capacity arising from growth in basic service and the emergence of new services and service providers within the UK makes the timely development of the numbering plan a central issue as we move into the 1990s.

Bibliography

FRANCIS, H. E. The General Plan for Subscriber Trunk Dialling. *Post Off. Electr. Engs. J.*, Jan. 1959, **51**, p. 258.

All-Figure Telephone Numbers. *Post Off. Electr. Engs. J.*, Apr. 1966, **59**, p. 40.

The following CCITT Recommendations are to be found in the CCITT Blue Book series (Ninth Plenary Assembly), Vol. II, Fascicles II.2 and II.4; Vol. III, Fascicle III.7 and Vol. VIII, Fascicle VIII.3:

E.160 Definitions relating to national and international numbering plans.
E.163 Numbering plan for the international telephone service.
E.164 Numbering for the ISDN era.
E.165 Timetable for co-ordinated implementation of the full capability of the numbering plan for the ISDN era (Recommendation E.164).
E.166 Numbering plan interworking in the ISDN era.
E.167 ISDN network identification codes.
E.212 Identification plan for land mobile stations.
E.213 Telephone and ISDN numbering plan for land mobile stations in public land mobile networks (PLMNs).
E.215 Telephone/ISDN numbering plan for the mobile-satellite services in INMARSAT.
E.216 Selection procedures for the INMARSAT mobile-satellite telephone and ISDN services.
F.69 Plan for Telex destination codes.
F.125 Telex numbering plan for the mobile-satellite service of INMARSAT.
I.330 ISDN numbering and addressing principles.
I.332 Numbering principles for interworking between ISDNs and dedicated networks with different numbering plans.
I.333 Terminal selection in ISDN.
I.334 Principles relating ISDN numbers/addresses to the OSI reference model network layer addresses.
X.121 International numbering plan for Public Data Networks (PDNs).
X.122 Numbering plan interworking between a Packet Switched Public Data Network (PSPDN) and an Integrated Services Digital Network (ISDN) or Public Switched Telephone Network (PSTN) in the short term.
X.180 Administrative arrangements for international closed user groups (CUGs).

Biography

Alistair McLeod joined the British Post Office in September 1958 as a Youth-in-Training in the Edinburgh Telephone Area. In 1964, he was appointed, via the Civil Service Limited Competition, to the Engineer-in-Chief's Office as an Assistant Executive Engineer where he worked on signalling system design and development. On promotion to Executive Engineer in 1971, he moved into switching development, specifying the requirements for trunk switching systems, including the RT14 register-translator that was subsequently used for the analogue derived services network. Promoted to Level 3 in 1981, he was involved in the early work on customer interfaces for the ISDN pilot (IDA) and took over the responsibility for the management of the BT PSTN numbering plan and the national aspects of the international data network numbering plan. In this capacity, he was chairman of the CEPT working team on numbering during the development of the CCITT Recommendation E.164. Appointed to Level 4 in 1986, he is now located in the Network Systems Engineering and Technology Department where he continues to have responsibility for numbering policy and standards. He is an Incorporated Engineer and a member of the IEEIE.

System Y—The Background to AXE10 in BTUK

R. B. SILVERSON†

After a detailed evaluation of digital switching systems, British Telecom, in March 1985, placed a contract with Ericsson Ltd. for the development of AXE10 for the BT network and for the supply of a quantity of exchanges.

INTRODUCTION

In little over 4 years, British Telecom and Ericsson have achieved more than one million in-service lines of AXE10 within the BT local network. This major milestone in BT's modernisation programme highlights one of the successes of the team which created the System Y project. Other achievements comprise the delivery of two phases of product development which include ISDN, an early Centrex capability and an advanced CCITT No. 7 signalling system.

HISTORY OF SYSTEM Y

The signing of a contract, in March 1985, between BT and Ericsson, for the adaptation of the AXE10 switching system to meet the needs of the BT local network and for the supply of a quantity of AXE10 exchanges represented the introduction of the second digital system into the UK local network.

The latter part of the 1970s saw the commencement of BT's modernisation strategy. Until the signing of the contract with Ericsson, the conversion of local exchanges to digital was totally dependent upon the supply of System X from GEC and Plessey.

BT's network modernisation strategy was established to improve service to its customers by:

- improving the quality of the existing services;
- increasing the rate of provision of service;
- introducing a greater range of services;
- providing a network which is responsive to market needs.

In 1982, BT decided to produce a comprehensive definitive specification of its digital exchange switching system requirements. It was important that the specification be non-system specific, enduring and sufficiently generic to be easily adapted to any digital switching system applications. This was in contrast to the approach as used for the early development of System X of collaborative (BT and industry) development specifications. The preparation of the technical specification became the first task of what became known as the *System Y project*.

The System Y project was established in order to accelerate the modernisation programme and to provide the opportunity to introduce an increased level of competitive procurement between the major switch suppliers of BT. By bringing a second digital switching system into the network, it was intended to provide for the migration of functionality into the BT network from the most advanced exchange developments which existed at the time.

Pre-evaluation documentation was produced and issued to all of the major world suppliers of digital switching equipment. The pre-evaluation took the form of a detailed questionnaire, the purpose of which was to elicit sufficient information on the digital switching product and the potential suppliers to produce a short list.

A full technical specification was also designed and produced such that:

(*a*) the number of constraints imposed on the suppliers was a minimum;

(*b*) largely 'off the shelf' offers were possible; that is, the system would interwork with the BT network with the minimum of adaptation; and

(*c*) the maximum amount of information about the systems was collected such that a comprehensive evaluation was possible.

In October 1984, a formal invitation to tender was issued to the short-listed suppliers. The invitation to tender documentation comprised:

(*a*) commercial schedules, principally to seek price information;

(*b*) commercial terms and conditions, which define the framework in which BT required to operate any contract; and

(*c*) technical specification and appendices.

Tenders were received on 30 November 1984 and the evaluation commenced.

CRITERIA FOR SELECTION

The system was selected following an in-depth evaluation of all aspects of the technical and commercial responses.

The principal commercial factors were the price of the product adaptation and the resultant

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programme cost, warranty terms, payment terms, and confidence in the supplier to meet his stated compliance to the delivery timescales. Cost and service conditions were other key factors as they are fundamental contributors to the lifetime costs of ownership and to the level of quality of service to be provided to BT customers.

The analysis of the technical offers included the architecture and capacity of the system, the hardware used, software structure and modularity, facilities offered, performance in terms of response times and the operation and maintenance features. It was also vitally important that the chosen system had a high degree of flexibility for growth and for enhancement without disruption to service. In addition, the system had to be capable of interworking with the existing BT network and to be suitable for evolution, in a cost effective manner, to meet the evolving network requirements.

THORN ERICSSON'S AXE10

Thorn Ericsson, a company (at that time) jointly owned by Thorn-EMI and LM Ericsson, provided the best overall technical and commercial package. The company also offered BT the earliest delivery date. It was successful in the world market and had proven experience of interworking with the BT network. Further, it had an existing UK manufacturing base in Scunthorpe and had more than sufficient production capacity to meet BT's deployment strategy.

In summary, the main strengths of AXE10 were:

- proven in-service performance on a world-wide basis,
- high level of compliance with BT's technical specifications,
- ability to meet customer network line card performance and to provide advanced features,
- a minimum level of adaptive engineering to interwork at both analogue and digital signalling levels, and
- its modular design in both hardware and software terms, using advanced technological components. This was felt to lead to a sound and reliable design capable of being readily enhanced.

One of the more important factors was supplier and system confidence. It was reassuring that there were more than 600 exchanges in service in over 40 countries world-wide with lines totalling over 4 million.

The contract was signed on 21 March 1985.

TECHNICAL FEATURES

It was planned that AXE10 would be introduced in a controlled way so that BT could gain maximum experience in the most resource-effective manner. The first year of orders were set at 106 000 lines over 25 exchanges. There would be a three-phase adaptive engineering programme to provide full network interconnection to the BT network, comply with all business feature needs and fulfil the BT administration requirements. The first exchange, at Sevenoaks, was introduced to service in October 1986.

The second-year ordering was set to a minimum of 300 000 lines, the ultimate volume being dependent upon the competitiveness of the system. The second phase of the adaptive engineering programme included enhanced CCITT No. 7 signalling, multi-line ISDN (30B + D) for integrated services PBX (ISPBX) interconnection, an X.25 interface for the administration network, a nodal Centrex capability, and more advanced customer features.

THE PERIOD 1985–89

For the first two years, all order handling (that is, dimensioning and installation engineering) was performed by LM Ericsson in Stockholm. Although initially most of the manufacture was carried out in Sweden, the UK factory at Scunthorpe produced a significant amount of equipment from the start. While a core of Swedish experts was brought in, Ericsson UK embarked upon a substantial programme of local recruitment in order to bring about a rapid technology transfer to the UK.

The Stockholm office project-managed the development activities by co-ordinating the work of five of Ericsson's European development centres as well as the Stockholm product verification task. Again, a significant amount of the design work was performed in the UK at a software development facility called *PCE* in Brighton.

Over the 4 year period since 1985, transfer of technology has continued such that the BTUK project has virtually become a wholly UK operation with technical back-up from Stockholm.

The massive build up in the installation and support function, coupled with developments for interconnection and for greater functionality and the transfer to virtually 100% UK manufacture, has resulted in some shortfalls in performance and a number of quality problems. However, both BT and Ericsson can take the credit that the programme of introducing BTUK's second digital switching system, an extremely ambitious task, has overall been successfully accomplished. In the drive to improve overall product and process quality, lessons continue to be learned and improvements effected.

CURRENT SITUATION

To date, BT has ordered 3 million lines of AXE10 of which 2 million lines have been accepted from the supplier. Currently, 1·4 million lines are in public service.

There are more than 80 host or parent exchanges and 220 remote concentrator centres. AXE10 exchanges have been installed across the whole of the UK with concentrations in the larger cities and towns.

Open Operating Systems

M. J. KIRK†

The information technology industry is becoming increasingly focused upon the concept of 'open systems'. The most common definition of an open system is that of a system based on international standards, implemented according to freely available definitions of interfaces and functionality.

The most widely publicised aspect of open systems is the Open Systems Interconnection (OSI) communications protocol suite. However, communications is only one of a number of distinct technologies necessary to implement truly open systems. This article examines one of the other important aspects of open systems, that of open operating systems.

The principal technical effort in this area is the IEEE POSIX initiative, primarily based on the UNIX operating system developed by AT&T. This work derives from the status of UNIX as the de-facto standard open operating system.*

Work is being performed within formal standards bodies, and within industry groupings. While most of the work is complementary, the sheer number of organisations involved can generate a misleading impression of conflicting developments. This article is an overview reference document on the standards activities and as such is a state-of-the-art report on those activities and how they interrelate.

INTRODUCTION

This article is concerned with the current explosion of activity in specifying and developing open operating systems. The involvement of many organisations, such as X/Open, OSF, NIST, The X Consortium, POSIX, etc., in this general area has produced a jumble of acronyms and tradenames which is potentially extremely confusing. Subsequent sections of this article describe the various organisations and initiatives and attempt to place them in the correct relationship to each other.

In order to discuss the subject of open operating systems, it is first necessary to place them in their proper context within the more general field of open systems as a whole. It is also helpful to define a hierarchy of standards/specification activities into which the various developments can be placed in order more easily to delineate their scope.

By virtue of the subject matter, this article is reliant on a heavy usage of acronyms. These 'words' are common usage within this technical specialism and a glossary of relevant acronyms is contained in Table 1.

ORIGINS OF OPEN SYSTEMS

The quest for truly 'open' systems is a phenomenon which has gained considerable momentum in the last 5 – 10 years. Starting from the development of the OSI communications standards and the introduction of the UNIX operating system as a commercial product, the ability to specify computer systems that are primarily non-proprietary has become an option of steadily increasing credibility.

The attractiveness of such an option to major users such as governments and large companies has led to a commitment to the development of open systems by all the major systems vendors. This mutual desire to be able to sell and to purchase open systems has in turn led to an explosion of standards activity across a wide range of technical areas.

The precise definition of an *open system* is the subject of wide debate. For the purposes of this article, the following definition is proposed: 'An open system is a system whose interfaces and functionality conform to freely available standards, such that a system conforming to those standards can be manufactured free of proprietary constraints.'

An important consequence of this definition is that in order to achieve the full potential of such systems, they ultimately need to be based on formal international standards, developed by a consensus process open to all. This requirement derives from the need to eliminate proprietary constraints from the specification.

In practice, many developers of open systems will choose to base their products on commercially available implementations of the relevant standards rather than to develop their own implementations from scratch. Within the field of open operating systems, this has resulted in the creation of a new industry segment to supply these standard implementations.

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* UNIX is a registered trademark of AT&T in the USA and other countries

TABLE 1
Glossary of Open Operating System Terms

	Definition	Comment
AEP	Application Environment Profile	
AES	Application Environment Specification	OSF environment specification
ANSI	American National Standards Institute	
API	Applications Programming Interface	
APP	Application Portability Profile	NIST environment specification
BSD	Berkeley Software Distribution	Major variant of UNIX
BSI	British Standards Institution	
CAE	Common Application Environment	X/Open environment specification
CBEMA	Computer and Business Equipment Manufacturers' Association	
CCTA	Central Computer and Telecommunications Agency	UK Government
CTS-2	Conformance Testing Service	EC funded programme
DIS	Draft International Standard	
DP	Draft Proposed International Standard	
EC	European Community	
FIPS	Federal Information Processing Standard	NIST specification
FTAM	File Transfer, Access and Management	OSI file management protocol
IEEE	Institute of Electrical and Electronic Engineers	US-based professional body
IS	International Standard	
ISO	International Standards Organisation	
NIST	National Institute for Standards and Technology	US Government
OSF	Open Software Foundation	Consortium producing AES, OSF/1
OSI	Open Systems Interconnect	ISO communications protocols
P1003	IEEE Standards Committee	POSIX standards
P1201	IEEE Standards Committee	X Windows standards
P1224	IEEE Standards Committee	X.400 API standards
POSIX	Suite of operating system standards	Produced by IEEE P1003
SVID	System V Interface Definition	Specification for AT&T UNIX System V
TCOS	Technical committee on operating systems	Part of IEEE Computer Society
TCSEC	Trusted Computer Systems Evaluation Criteria	US Department of Defense document
UI	UNIX International	Consortium for promotion of UNIX System V
UIDL	User Interface Definition Language	
UNIX	AT&T's operating system product	Historical basis for open operating system standards
UPE	User Portability Extension	P1003.2 document
USO	UNIX Software Operation	AT&T's UNIX development division
X.400	OSI message handling	
X.500	OSI directory services	
X/Open	An international vendor consortium	Promotes use of open standards
X3	CBEMA's Information Processing Standards Committee	
XPG	X/Open Portability Guide	Contains CAE specification

SCOPE OF OPEN SYSTEMS

The goal of open systems is to maximise portability of applications, data, and people. In order to develop a true open system, several key elements have to be provided:

- Operating system
- Communications
- User interface
- Programming languages
- Data management

It is of course possible to integrate any individual element into a proprietary framework, for instance, providing OSI communications protocols in conjunction with a proprietary operating system. In this case, some of the benefits of open systems are provided, but others are not. This example would allow for the transfer of data between the proprietary system and an open system, but would not provide portability of applications or users to the same extent as is possible between two open systems in which all the elements are provided.

The existence of a standard for any of the elements listed above does not necessarily preclude the development or existence of other open standards in the same area. If that were the case, then it would effectively stifle future evolution of information technology (IT) systems, a clearly undesirable result. It does, however, imply that in order to gain the necessary wide support to enable it to pass through the standards making process, a new proposal has to offer advantages not possible within other existing standards.

This article is primarily concerned with the area of operating systems, and will only touch on the other areas where there is some direct connection with the operating systems activities. Open operating systems standards principally address the areas of application and user portability.

HISTORICAL PERSPECTIVE

The open operating systems standardisation process has come about largely as a result of the increasing use and availability of the UNIX operating system. The existence of the UNIX system on a wide range of hardware platforms demonstrated the feasibility of a portable operating system, and stimulated interest in the whole question of standardising operating system interfaces. Part of the continued development of the standards process has been the increasing awareness that the interfaces are not restricted to the UNIX system, and that they can be implemented on any operating system which was capable of providing the necessary functionality.

The first version of the UNIX operating system was implemented at Bell Laboratories in 1969. It was originally written in assembly language for a PDP-7 processor. Subsequently, it was transferred to a PDP-11 and then re-implemented in the C programming language. Internal development continued within Bell Laboratories for some years, and, in 1976, Version 6 was made available externally. The first commercial implementations supplied by licensees of the UNIX system were based on Version 7, which was released in 1978.

AT&T continued to develop UNIX and, in 1983, UNIX System V became the first supported release. This development has continued, culminating in the release of UNIX System V Release 4.0 in late-1989.

As well as development at AT&T, parallel development also took place at the University of California at Berkeley. Starting with an AT&T system that ran on VAX systems, the Computer Science Research Group at Berkeley developed the technology to produce 3BSD, (the Berkeley Software Distribution), in early-1980. Subsequent development has now reached 4.3BSD.

The work at Berkeley extended the UNIX system in a variety of ways, introducing demand paging, TCP/IP based networking, and many user command enhancements. The BSD system was used by many vendors as the basis of their commercial implementations.

One result of this parallel development was a degree of divergence which contributed to the need to define a common standard. The theme of the late-1980s has been convergence. Thus AT&T's UNIX System V Release 4.0 contains most of the enhancements contained in the BSD systems, and Berkeley-based vendors have been implementing System V interfaces into their products.

The standards process was in part initiated by this need to achieve convergence within the UNIX community. The standards contain interfaces from both major variants, as well as an awareness of the needs and capabilities of other operating systems.

HIERARCHY OF SPECIFICATIONS

Within the area of open operating systems it is possible to identify a hierarchy of specifications, each level of which fulfils a particular niche in the process of producing a complete definition of an open operating system.

The hierarchy, shown in Figure 1, is composed of four identifiable layers:

- Formal standards
- *De-facto* standards and profiles
- Standard implementations
- Proprietary implementations

The levels of the hierarchy are characterised in two ways, by the process which establishes them, and by the output they produce. These characteristics are summarised in Table 2.

Figure 1
Hierarchy of specifications

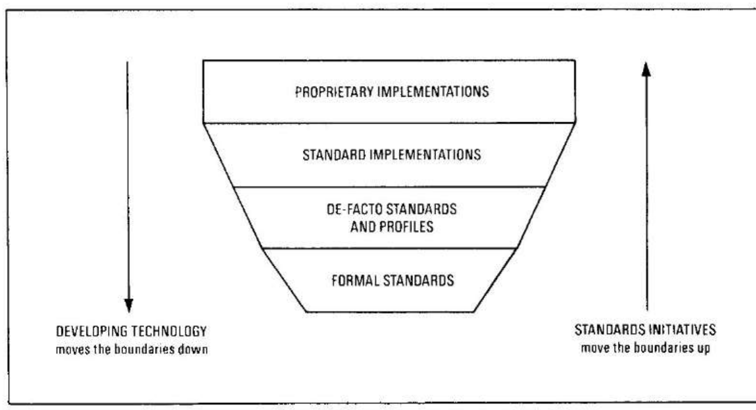

TABLE 2
Hierarchy Characteristics

	Decision Process	Output	Example
Formal Standards	Open	Specification	IEEE POSIX
De-Facto Standards and Profiles	Restricted	Specification	X/Open
Standard Implementations	Restricted	Implementation	OSF UI/AT&T
Proprietary Implementations	Closed	System	DEC, IBM, HP, etc.

Formal Standards

Formal standards are developed by organisations such as ISO. In some cases, the development is actually performed by national standards bodies such as ANSI and subsequently adopted by ISO after a suitable review process.

One of the key attributes of these formal standards is that they are developed by an open consensus process. The end-product of the standards process is solely a specification. It is common that the standards contain options arising from the consensus process, and it is often necessary to generate profiles of the standards to meet specific needs.

De-Facto Standards and Profiles

At this level, in the hierarchy there are two similar entities, *de-facto* standards and profiles.

Within the open operating systems arena, the process of formal standardisation is still at an early stage. In order to specify a realisable system it is necessary to combine the existing formal standards with other *de-facto* industry standards. This role is performed by organisations such as X/Open.

In addition, other organisations, notably governmental agencies, such as the CCTA and NIST, are eager to specify profiles for use in procurement specifications. Profiles are concerned with how standards will be used in a specific environment and include issues such as the selection of options contained within the standards. Thus, two systems implementing the same profile will be equivalent. Clearly, multiple profiles can be created, selecting different sets of options, and combining together different sets of standards.

Both these activities are concerned with specifying systems that can be built and procured. As with the formal standards, the output of these processes consists of a specification. The process by which this level of specification is produced is less open than that for the formal standards, being restricted to a limited set of participants, such as X/Open members, or government agencies.

An important point to bear in mind is that the formal and *de-facto* standards produced at these lower two levels of the hierarchy are not generally constrained by issues of backwards compatibility. This becomes an issue once actual implementations are involved.

Standard Implementations

The lower levels of the hierarchy purely produce specifications. Within the open operating systems area, there are organisations such as the OSF and UI that are producing implementations of those specifications. The implementations run on a set of one or more reference machines and need to be 'ported' to the desired hardware by the purchaser. As such, these implementations are targetted at systems vendors or large end-users that have the technical expertise to make use of them.

Within the open operating systems area, the organisations producing the standard implementations have a membership structure and are supported and guided by a large number of vendor and end-user organisations.

Proprietary Implementations

The final level of the hierarchy is occupied by vendors' proprietary implementations. While their open operating systems products are based on the standards and profiles from the lower levels of the hierarchy, they will also include value-added elements that serve to differentiate their particular system. Such elements include interworking with the vendor's proprietary systems and networks, and enhanced functionality.

Where a vendor has an existing customer base for the products into which standards conformance is being introduced, issues of backwards compatibility become important. A key characteristic at this level is that the vendors' products tend to be complete systems.

FORMAL STANDARDS

Development of formal operating system standards is being undertaken within the Institute of Electrical and Electronic Engineers (IEEE) in the USA. The IEEE operating system work is being submitted to the ISO for adoption as full international standards

IEEE-CS TCOS

The IEEE Computer Society Technical Committee on Operating Systems (IEEE-CS TCOS) is sponsoring several initiatives related to open operating systems. These are P1003 (POSIX), P1201 (X Windows System), and P1224 (X.400).

The IEEE process is open to anyone, although in order to vote on a standard, it is necessary to be a member of the groups. When a working group has finished working on its draft document, a balloting group is formed. Technical reviewers, usually drawn from the working group, have the job of resolving objections that arise during the balloting process. The target dates for balloting by the various IEEE operating system related working groups described in the following sections are summarised in Table 3.

TABLE 3
IEEE Standards Group Balloting Status (as at 25/6/89)

IEEE Group	Topic	Ballot Target Start	End
P1003.0	POSIX Guide	?	?
P1003.1	System Interface	COMPLETED	
P1003.1a	ISO Alignment	8/89	Q4/89
P1003.1b	Supplement	Q2/90	Q1/91
P1003.2	Shell and Tools	1/89	Q2/90
P1003.2a	User Portability Extension	Q2/90	Q1/91
P1003.3	Test Methods	5/89	Q2/90
P1003.4	Realtime	Q1/90	Q4/90
P1003.5	Ada Binding	4/90	Q4/90
P1003.6	Security	7/90	Q4/90
P1003.7	System Administration	10/90	Q3/91
P1003.8	Transparent File Interface	Q3/90	Q3/91
	Process to Process	10/90	Q3/91
	FTAM API	?	?
	Remote Procedure Call	?/91	?
	Directory Services/Name Spaces	?	?
	X.500 API	?	?
P1003.9	Fortran Binding	4/90	Q4/90
P1003.10	Supercomputing	10/90	3/91
P1003.11	Transaction Processing	?	?
P1201.1	Toolkit API	4/90	Q2/91
P1201.2	Driveability	4/90	Q2/91
P1201.3	User Interface Definition Language	?	?
P1224	X.400 Gateway API	3/90	Q1/91

IEEE P1003 (POSIX)

The IEEE POSIX initiative is probably the best known of the operating systems standards activities. Indeed, the name POSIX has become synonymous with open operating systems. Currently, it is generally used to refer to the P1003.1 System Interface standard. In fact, the P1003 committee is divided into 12 working groups.

The primary remit of P1003 is to define interfaces needed for applications portability. The basic thrust of the work has been to standardise existing practice, as embodied in the UNIX operating system. Some more recent POSIX working groups are concerned with aspects of 'people portability', defining aspects of the system that are primarily targetted at users rather than portable applications.

P1003 meets quarterly, usually in the United States. Occasional meetings are held outside the USA, the October 1989 meeting being held in Brussels, hosted by the European Commission. Total attendance at the P1003 meetings, covering all 12 groups, is of the order of 300 people, representing most of the major vendors and users.

P1003.0 Guide to POSIX Open Systems Environment

The P1003.0 group is working to produce a guide explaining how applications portability is achieved in a POSIX environment. The guide is designed to set out how end-users should decide which standards they should use for their own particular environment.

P1003.1 System Interface

This group is the original POSIX working group and is concerned with the low-level interfaces between the operating system and applications. It addresses basic functionality such as process creation, file access, and terminal handling.

Formed in 1985, the group took as a starting point a standard developed by a US user group[1] and proceeded to develop it into a formal IEEE standard.

The P1003.1 standard was approved in 1988[2] and was recommended for adoption by ISO as an International Standard[3] in October 1989.

P1003 is currently working on two supplementary documents. The first is a consolidating document that will correct some errors in the existing standard. It also contains changes to accommodate the forthcoming ANSI C standard. The second will incorporate new functionality that has achieved a wider consensus in the industry than was previously possible.

P1003.2 Shell and Tools

Within UNIX systems, the command interpreter is known as the *shell*. Besides being a command interpreter, it also implements a programming language which enables the implementation of complex command scripts.

The purpose of the Shell and Tools working group is to standardise a set of commands necessary for the production of portable shell scripts. It deliberately excluded interactive commands that were 'user-oriented'.

The P1003.2[4] document specifies a command language based on the UNIX System V shell, with some new features influenced by more recent developments such as the Korn Shell[5]. It also defines some 70 commands useful to portable applications.

The document is currently in the balloting process and it is expected to be adopted in 1990. The draft is currently issued as a Draft Proposed Standard within ISO[6].

P1003.2 is also working on another document, the User Portability Extension (UPE). This will cover the user-oriented commands excluded from the first document, embracing such functionality as screen editors and other commands targetted at experienced users.

P1003.3 Testing and Verification

The P1003.3 group is focused on the problem of developing a method for testing the conformance of systems to the POSIX standards. It has defined a testing method and a set of test assertions intended to test conformance to the P1003.1 standard. This document[7] is currently being balloted and the group is now starting to develop test assertions for the P1003.2 standard.

Various organisations, including X/Open and NIST, are developing test suites based on the P1003.3 assertions.

P1003.4 Real-time Extensions

This group is working on a set of extensions to the P1003.1 standard to provide the functionality required by real-time systems. Areas of work include interprocess communication, high performance file systems, high-resolution timers, and priority based scheduling.

P1003.5 Ada Bindings

Currently, the P1003.1 standard is specified in terms of a C language interface. In order to meet the requirements of ISO, the IEEE standards are being reformulated in a programming language independent form, and new standards will be developed in this form. The language independent standards will be accompanied by bindings to appropriate programming languages.

As part of this process, the P1003.5 group is defining an Ada language binding to the P1003.1 standard. This exercise has shown up some problems that arise from simply defining standards in terms of the C language interface, which carries with it some implied semantics that cannot be implemented in all other languages.

P1003.6 Security Extensions

The P1003.6 Security group is concerned with defining interfaces for security extensions to the P1003.1 standard.

They are specifically oriented towards the US Department of Defense Trusted Computer System Evaluation Criteria, (the 'Orange Book')[8]. The interfaces that they are developing are concerned with discretionary access control (access control lists), mandatory access control (labelling of subjects and objects), auditing, and least privilege operation.

P1003.7 System Administration

System Administration is a relatively new group within P1003. The group has the task of developing interfaces that will allow operators and administrators to perform routine system administration functions.

Areas of interest include user administration, file system management, process management, and system monitoring. The group has interoperability between heterogeneous systems as a major goal, and is investigating the use of the OSI management model to help achieve this aim.

P1003.8 Distribution Services

The P1003.8 Distribution Services group is currently organised as a number of sub-groups dealing with various networking issues. Some of these issues are POSIX-specific, and some are applicable to both POSIX and non-POSIX systems. It is probable that in the future the various sub-groups will be constituted as groups in their own right. At this point, the non-POSIX specific groups will be moved out of P1003 into at least one more project under IEEE-CS TCOS.

The POSIX specific activities include:

(*a*) *Transparent File Access* This group is initially concerned with the issues related to applying the P1003.1 standard to non-local access in a user-transparent fashion. Later topics will include the definition of a useful subset of the P1003.1 standard in a networked environment, and the adoption of a data stream encoding to support interconnection of systems.

(*b*) *Protocol Independent Process to Process Communication* This group is concerned with providing a protocol-independent interface to communication services between processes. Eventually, this may not be limited to POSIX systems. It is hoped that both a simple high-level interface and a more detailed interface will be provided. The detailed interface will be more complex, but also more flexible, allowing access to specific protocol features while retaining the protocol independent nature of the interface.

(*c*) *Remote Procedure Calls* The purpose of this group is to define a model and applications programming interface (API) for using remote procedure calls. This work may also be capable of being applied to non-POSIX systems.

(*d*) *Directory Services and Name Spaces* This group is concerned with the specification of the name spaces supported by POSIX systems, and the provision of an API for directory services to support them.

Non-POSIX specific activities include:

(*a*) OSI file transfer, access and management (FTAM) API;

(*b*) OSI mail services (X.400) API (see P1224); and

(*c*) OSI directory services (X.500) API.

P1003.9 FORTRAN Bindings

This group is concerned with FORTRAN language bindings to the P1003.1 standard.

P1003.10 Supercomputing

The Supercomputing group has the task of producing an application environment profile (AEP) which will specify the requirements that the supercomputing environment places on the other POSIX standards, as well as standards from other bodies.

Supercomputing is defined as being characterised by jobs that require very large amounts of CPU time and memory. Efficient batch processing and checkpointing capabilities are often required.

P1003.11 Transaction Processing

The P1003.11 group is also targetted to produce an AEP, in this case defining the requirements of the transaction processing environment.

It is expected that this will involve considerable use of facilities from the P1003.4 real-time extensions and from the ANSI X3H2 Database Committee. The OSI TP protocol[9] is also under consideration within this group.

IEEE P1201 X Windows

The P1201 project is concerned with standardising aspects of the X Windows System. While X Windows is closer to the user interface component of open systems than the operating systems, it is not in itself a user interface. It is, rather, an enabling technology that facilitates the development of user interfaces.

There is currently a single group, P1201.1, in this area, with two other groups proposed. P1201.1 is concerned with a standard toolkit API for X Windows. It is examining offerings from AT&T and the OSF.

The two proposed groups are concerned with 'driveability' and User Interface Description Language (UIDL). Driveability is related to questions of 'look and feel' such as the consistent use of mouse buttons for generic functions; for example, selection and deletion. UIDL is concerned with the ability to describe a user interface at a higher level than look and feel, independent of specific presentation issues.

IEEE P1224 X.400 Gateway API

To date, one of the non-POSIX specific networking sub-groups has been constituted as a separate project. P1224.1 is working with the X.400 Gateway API[10] developed by the X.400 API Association. This specification was brought into the IEEE as a means of promoting it to the status of a formal standard in a timely fashion.

American National Standards Institute (ANSI)

Besides the IEEE, ANSI has also accredited other standards development groups, including X3, which is sponsored by the Computer and Business Equipment Manufacturers' Association (CBEMA). X3 has several work items related to the IEEE work, including the X3J11 (C Programming Language), and X3H3.6 (X Windows).

In the specific area of X Windows, there is currently a proposal from ANSI that the IEEE should take steps to standardise the Xlib interface.

X3J11 C Programming Language

Although the POSIX standards will ultimately be programming language independent, there will continue to be a strong link between POSIX and C for some time. This is essentially a historical relic arising from the fact that UNIX was implemented in C.

The ANSI standard[11] is about to become adopted, as soon as it completes the processing of an appeal. It is also being progressed through the ISO process.

X3H3.6 X Windows

The X3H3.6 committee is working on aspects of X Windows that are complementary to the work being performed within the IEEE. X3H3.6 is working on the X Wire Protocol which is the lowest layer of the X Window System.

Essentially, X3 is addressing X Windows from the bottom up, with IEEE working from the top down.

International Standards Organisation (ISO)

Within ISO, the POSIX standards are handled by a working group, JTC1/SC22/WG15. This working group is charged with taking the standards produced within IEEE P1003 through the international review procedures that are necessary to create an international standard.

At the most recent meeting of the working group, the IEEE approved P1003.1 standard was recommended for adoption as a full international standard. The international standards for open operating systems will be organised as two series of documents, one containing the language independent specifications, and the other containing the programming language bindings. The contents of these document series are summarised in Table 4.

TABLE 4
ISO Document Organisation

Document	Content
	Language Independent Specifications
9945-1	Programming Interfaces
9945-2	User Interfaces
9945-3	System Administration Interfaces
	Language bindings
XXXX-1	C Language Bindings
XXXX-2	Ada Language Bindings
XXXX-3	FORTRAN Language Bindings
—	Other Language Bindings

DE-FACTO STANDARDS AND PROFILES

At the time of writing, only one of the POSIX standards has completed its passage through the IEEE and reached the state of a formal standard. Consequently, there is major activity in the areas of *de-facto* standards and profiles specifying systems that can be implemented as interim solutions while the standards mature.

X/Open

X/Open was originally formed as a consortium of five European computer manufacturers: Bull, ICL, Siemens, Olivetti and Nixdorf. It now has 21 members, including major US and Japanese companies and both The Open Software Foundation (OSF) and UNIX International (UI). Most of the major vendors of UNIX systems are represented, either directly or via the OSF and UI. (X/Open has no organisational connection with the X Consortium developing the X Window System.)

X/Open exists to promote open systems by defining a common applications environment (CAE) which will be supported by vendors and allow applications developers to target their products at a wide range of systems. The availability of a large number of third-party applications capable of running on X/Open CAE compliant machines is intended to increase the desirability of those machines in the marketplace.

X/Open seeks to achieve its aims by publishing the X/Open Portability Guide (XPG)[12]. This document, the third edition of which was published in 1988, specifies a CAE based on POSIX and other related standards. Where no applicable standard exists, the guide makes use of suitable draft standards or current existing practice. X/Open has a commitment to incorporate the formal standards as they are adopted, thus there can be some degree of change between different editions of the Portability Guide. The third edition, (XPG3), supports the P1003.1

standard, and uses a draft of the P1003.2 standard as an interim solution.

XPG3 is published in seven volumes, the contents of which are summarised in Table 5.

In addition to publishing the Portability Guide, X/Open has also established *branding* programs whereby systems and applications can be certified as conforming to the X/Open CAE and can then carry the X/Open brand.

TABLE 5
X/Open Portability Guide Organisation

Volume	Contents
1	XSI Command and Utilities
2	XSI System Interfaces and Headers XSI System Interfaces XSI Headers
3	XSI Supplementary Definitions XSI Internationalisation XSI Curses Interface XSI Source Code Transfer
4	Programming Languages C Language COBOL Language
5	Data Management Indexed Sequential Access Method (ISAM) Structured Query Language (SQL)
6	Window Management X Window System
7	Networking Services Transport Interface Personal Computer Internetworking

National Institute of Standards and Technology

The National Institute of Standards and Technology (NIST), formerly the National Bureau of Standards (NBS), is a US government agency involved in both standards creation and use.

In the field of information processing, NIST publishes Federal Information Processing Standards (FIPS). These documents, based on formal standards, provide specifications for use by US federal agencies in procuring systems and software. The FIPS, along with selected additional standards, make up the NIST application portability profile (APP).

NIST is highly committed to providing fully open specifications as soon as possible, and makes use of the POSIX work in many cases. NIST has published FIPS 151-1[13], based on the System Interface (P1003.1) standard. Where P1003.1 has options, the FIPS mandates the settings to be used in a FIPS conforming system.

The relatively long timescales associated with the formal standards process is not always consistent with the needs of NIST to provide a FIPS in a timely manner. When this occurs, NIST has adopted a current draft of the relevant standard for use as an interim FIPS pending the completion of the formal standard. This situation was reached with the P1003.1 standard and the original FIPS-151 was subsequently updated to reflect the final standard.

NIST is currently working on draft FIPS documents covering Shell and Tools (P1003.2), System Administration (P1003.7) and aspects of X Windows.

Finally, NIST has strong interests in the issues of conformance testing. It has developed and distributes a test suite that tests conformance to FIPS-151.1, (and thus P1003.1). It is currently working on a test suite for P1003.2.

STANDARD IMPLEMENTATIONS

The economics of operating system development mean that, when faced with the problem of implementing the contents of a specification, many manufacturers choose to purchase an off-the-shelf implementation and then 'port' it to their own specific hardware. There are currently two principal commercial sources of standard implementations, UNIX International/AT&T, and the Open Software Foundation.

The computing trade press often depicts the relationship between UI and the OSF as extremely antagonistic. It is important to remember that, while they are commercial rivals, they have essentially the same technical goals, as is shown by the fact that they are both members of X/Open. The systems produced by both organisations are based on the same standards. It is also important to note that a significant number of companies are members of both organisations.

In the related windowing area, the X Consortium provides the standard implementation of the X Windows system.

Open Software Foundation

The Open Software Foundation (OSF) was formed in 1988, to provide an alternative source of open systems technology. Part of the inspiration for its formation was a desire by several large vendors to have more influence over the direction and development of UNIX than they felt was possible with the structure that AT&T had at the time. The OSF is a non-profit making organisation which develops both specifications and products based on industry standards.

The OSF had seven founding members, including DEC, IBM, and Hewlett-Packard, who each subscribed a significant amount of money in order to establish the organisation. Since its inception, the OSF has attracted approximately 150 members. The OSF develops products and specifications by means of the 'request for technology' (RFT). It issues an RFT in a particular technical area soliciting proposals from anyone, including non-members. The selection

process is open to OSF members, with the final decision being made by the OSF staff. OSF specifications are referred to as *application environment specifications* (AES).

To date, the OSF has released one product, OSF/Motif, which is a user interface system running on X Windows. It is based on technology from HP, DEC, and Microsoft.

The OSF operating system, OSF/1, will be based on AIX Release 3 from IBM, which in turn is derived from UNIX System V Release 2 from AT&T. When it is released, currently scheduled for 1990, OSF/1 will conform to the P1003.1 and XPG3 specifications. Subsequent releases will contain support for the rest of the POSIX standards as they are completed.

The members of the OSF are not required to make a commitment to use the OSF/1 product. In many cases, they have stated that they will integrate 'relevant technology' from OSF/1 into their own systems.

UNIX International/AT&T

In response to the formation of the OSF, AT&T and several of the major suppliers of UNIX System V formed UNIX International (UI). UI has the role of promoting UNIX System V and advising AT&T on the direction that subsequent development of the system should take. An important aspect of UI is to provide a means for System V licensees and end-users to influence the future of System V. UI has now attracted over 100 members.

UI has an open process whereby the membership can meet to influence the direction of System V. It has a number of working groups addressing various technical and licencing issues. Unlike the OSF, UI does no development work. The job of actually developing and licencing System V remains with AT&T.

In order to enhance the perception of openness in the development process, AT&T has separated the development of UNIX from the part of its business that develops computer systems. UNIX is now developed by the UNIX Software Operation (USO), and AT&T's computer systems operation now receives UNIX technology from USO on the same terms and at the same time as any other licensee.

The definition of UNIX System V is contained in the System V Definition (SVID)[14]. Initially developed by AT&T as an open specification of the System V Release 2 interfaces, it formed the basis of much of the subsequent standards work. The SVID addresses issues of backwards compatibility and is the reference document for the technical evolution of System V.

One of the key aspects of the UI/USO is that they exist to promote and develop System V. Most of the vendors who belong to UI are existing suppliers of UNIX System V. Thus they provide an evolutionary development path from existing System V systems. The latest version of UNIX System V, Release 4.0, entered general availability in late-1989, and conforms to both P1003.1 and XPG3. As with the OSF, UI/USO are committed to incorporate future standards as they are completed.

X Consortium

The X Consortium is an organisation devoted to the continued development of X Windows. Initially developed at MIT under funding from IBM and DEC, X Windows is in the public domain, a factor that has heavily influenced its adoption throughout a large part of the computer industry.

The X Consortium was founded by the major workstation manufacturers, many of whom were building their systems around X Windows technology. Membership include DEC, IBM, HP, Sun, and Tektronix.

The X Consortium acts as a focus for technical development of X Windows and as a forum for debate as to the directions that the development should take.

PROPRIETARY IMPLEMENTATIONS

Many vendors, including British Telecom, currently include UNIX systems within their product portfolios. These vary from small companies who are effectively reselling 'vanilla' AT&T UNIX, to major corporations for whom UNIX is merely one aspect of their portfolio which has to interwork with their proprietary systems.

The impact of operating system standards on the many available implementations is to enhance the portability of both applications and people between machines from different vendors. As the portfolio of standards is steadily filled, the degree of portability will rise.

The existence of standards also has a major commercial effect, removing many of the traditional factors used to discriminate between proprietary operating systems. With functionality and interfaces standardised, the emphasis shifts to issues such as price/performance, reliability, and quality. It becomes much harder for a user to be 'locked-in' to a particular vendor. 'Lock-in' can still arise from the use of proprietary 'value-added' features, but this is much more likely to be due to a conscious decision by the user, rather than being a fundamental issue of vendor selection.

BT INVOLVEMENT

British Telecom is involved in many aspects of the open systems standards process. Within the field of operating systems, BT is active within the IEEE, ISO, and X/Open.

BT participates in several of the IEEE committees, notably P1003.2 Shell and Tools, P1003.6 Security, P1003.7 System Administration, P1003.8 Distribution Services, and P1201

X Windows. It is also active in the international standards area, both within the BSI and ISO.

BT is a member of the X/Open User Council. In a European context, BT is a member of a consortium, led by the National Computing Centre, to set up and run a European POSIX Conformance Testing Service under the auspices of the EC CTS-2 programme.

References

1 /usr/group Standard, 1984.
2 IEEE P1003.1-1988, 1988.
3 ISO IS 9945-1.1989, 1989.
4 IEEE P1003.2 Draft 9, 1989.
5 BOLSKY, M., and KORN, D. The Korn Shell, Prentice Hall, 1989.
6 ISO DP 9945-2, 1989.
7 IEEE P1003.3 Draft 10, 1989.
8 Department of Defense Trusted Computer System Evaluation Criteria, DOD 5200.28-STD, Dec. 1985.
9 ISO DP 10026, 1989.
10 X.400 Gateway API Specification, Version 4.0, June 1989.
11 ANSI/X3.159-1989, 1989.
12 X/Open Portability Guide, 1988.
13 FIPS-151-1, 1989.
14 AT&T System V Interface Definition, Issue 2, 1988.

Biography

Martin Kirk joined the British Post Office in 1975. He worked on the Pathfinder experimental stored-program control (SPC) exchange and on automatic code generation techniques. In 1985, he became Head of the UNIX Operating System Support and Development Group. He is active in UNIX development and standards. He is Vice-Chairman of the IEEE P1003.7 System Administration working group.

Assuring Quality in Software—Practical Experiences in Attaining ISO 9001

P. J. RIGBY, A. G. STODDART, and M. T. NORRIS†

In September 1989, the Systems and Software Engineering division of British Telecom Research Laboratories became the first unit of its kind to be registered to the ISO 9001 quality standard. This article describes the process by which this was achieved and discusses the key lessons learned along the way.

INTRODUCTION

The Systems and Software Engineering (SSE) division of British Telecom Research Laboratories (BTRL) is based within the Research and Technology (R&T) department of BT at Martlesham Heath. The aim of the division is to find, and transfer into the rest of BT, improvements in software technology[1]. The prime objective of doing this is to reduce the whole life-cycle costs of software development and ownership to the rest of the business. The scope of the activity covers all aspects of software technology from requirements capture to maintenance, and all the major stages in between: design, metrics, project management, etc.

Software is notoriously difficult to control. Software enabling technologies are even more difficult since techniques and concepts are even less tangible than code[2]. Given this, the adoption of well documented working procedures is a key element in ensuring quality. This article details the process by which SSE implemented, installed and tested the procedures which form the basis of a quality management system (QMS) to meet the standards of ISO 9001[3] and BS 5750[4]. These are, respectively, the international and British standards for quality systems. They are identical in content to the European EN 29001 standard to which SSE is also registered.

The scene against which the QMS was developed, and the background to the path chosen, are discussed in the next section. Subsequent sections deal with the procedural and people aspects of installing a quality management system. Finally, the mechanics of testing the QMS against the standard are detailed and a set of key lessons during the whole exercise are listed.

The production of the QMS within SSE started in November 1986, and registration was obtained to ISO 9001 in September 1989. The division is, according to the British Standards Institute (BSI), the first software research organisation to obtain BS 5750 in the UK and the first to gain ISO 9001 in Europe.

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EARLY DAYS

The first stage in taking up any new challenge is to discover the existing situation, evaluate what is there, assess its worth and find what is needed to produce the desired result. The starting point of the SSE drive for ISO 9001 registration can be traced to the Technology Executive Quality Improvement Programme (TEQUIP), which was initiated in early-1987. The SSE quality team representative on the TEQUIP programme was responsible for a large proportion of the specifications produced by the initiative. These specifications were designed to form the core of a set of procedures that would meet the requirements of a BTRL quality system. The basic principle behind TEQUIP was to produce, for some of the divisions within BTRL, a QMS which could be used for the rest of the divisions. The programme provided a good deal of useful data upon which the SSE was subsequently to build.

The first major step towards registering the SSE QMS was the decision to write a Divisional Quality Manual tailored to ISO 9001 requirements. In order to do this, the original TEQUIP specifications which related specifically to the operation of the division had to be substantially revised to ensure their compliance with all parts of ISO 9001.

The second important step was to look at how the division operated and to document it. The method used was very similar to the department purpose analyses[5] used in total quality management (TQM) initiatives. The existing divisional business plans together with the 5 year forecast plan provided the rest of the information required.

One of the major realisations once the above work had started was that all the work performed in the division could readily be defined in a standard project format. In production at the time was the R&T guide to project management—the Project Control Handbook (PCH)[6]. This proved to be the single most

useful document in guiding the installation of the divisional quality system. The PCH was used as the basic guide to project management within the division and was readily applied to the quality project.

At the same time, a number of other important aspects of the division's work which had to be controlled were identified. These ranged from the mundane—text standards and document styles—to the more esoteric aspects of the division's work—how to provide consultancy, formalising the planning of conference submissions etc.

By the end of 1988, it was clear what had to be done. The basic ideas and aims were in place. The rest was simply hard work, alleviated by the fact that a number of relevant procedures either already existed (for example, R&T instructions) or could be readily adapted (elements from the R&T Software Centre, Belfast, and BT/CSD/CFM quality systems).

ASPECTS AND MECHANICS OF QUALITY SYSTEMS

The basics of quality are very simple: to be under control and to be able to prove it. To do this you must be able to:

- Say what you do
- Do what you say
- Be able to prove it

For practical purposes, the above list should be augmented with the need to continually improve. It is at this stage that the real gain of installing a quality system accrues.

There has grown up in recent years a perception that financial management, project management and quality management are fundamentally different. This has proved not to be the case: they are just different ways of viewing the same management problem. In accepting this view, it becomes impossible to produce a quality product or service without having in place a formal project management system. This automatically leads to a clarification (and subsequent improvement) in financial management and quality.

When the division took project management on in the form of the Project Control Handbook, it formalised the project control already in use within the division. Every project was required to produce project and quality plans together with the financial information specified in the PCH. In addition, all project documents, not just quality documents, were reviewed to the well tried Q star standard. During the reviews, emphasis was placed on short, simple and accurate documents.

Given the PCH as an operating standard, the next step was to link it with the major practices and procedures of the division. A common configuration management and change control approach was adopted to ensure that:

(*a*) all documentation has the appropriate form of authorisation,

(*b*) the pertinent issues of the appropriate documentation are available at all locations where required,

(*c*) all changes to documentation are authorised and processed in a uniform manner, and

(*d*) provision is made for the removal of obsolete documentation and software from all points of issue and use.

These principles were extended to all parts of the SSE, including staff engaged on long term software research. The local method for controlling this research is incorporated in the divisional QMS.

CREATING THE RIGHT ENVIRONMENT

The right environment for creating an accredited QMS requires firstly senior management commitment, and secondly active project management. This is all that is needed to install a QMS. The commitment from the rest of the staff, which is essential to its operation, has to be earned by the management team.

This is the stage at which 'buy in' is essential. A very effective way of encouraging this is to get the staff who need the procedures to write them. This not only ensures accuracy, but also makes the author (and all the people consulted) feel they own part of the quality system. Acceptance is hence greatly eased.

The next method to encourage 'buy-in' is to introduce quality representatives or quality circles. The former were chosen within SSE using one representative for each group, preferably a volunteer. The job of quality representative must, like any job, have a job description that contains authority, accountability as well as responsibilities. The function of the representatives is essentially to disseminate information and feed in problems and suggestions on how to improve quality within the division. Over time, the quality representatives turned from being passive observers to be the biggest critics of both the QMS and the quality team, and hence provided significant input to improving both.

A second key aspect of getting buy-in is that education and news about the QMS are required. The main vehicle here was a divisional magazine, called *Keyword*, which carried articles in every issue prior to BSI assessment. Electronic mail was also used for 'hot' news such as the announcement of division-wide issues resulting from audits. The key point is that the visibility of the quality drive within the division needs to be kept up using a variety of media. As a result, the staff who have to use the QMS tell you what is used and what should be in the QMS. This is essential both as a check on quality and as an indicator that the QMS is being taken on. In practice, *Keyword* also provided useful feedback on the quality team's visibility to the division. In one issue, the definition of an auditor was published as 'Someone who comes round after the battle and shoots the wounded'. The appearance of such quips was a good sign: quality was

now being treated as a serious subject which could be joked about and we knew we were winning. In hindsight, it is clear that this area is one where more exposure is always worthwhile. The trick is to maintain the balance: too much can lead to a blasé attitude, too little generates no interest.

CONTEXT AND AN OVERVIEW OF THE QUALITY MANAGEMENT SYSTEM

It became clear as the quality project developed that there were two important issues in ensuring the effective introduction of the QMS. The first was putting it into context with respect to the other instructions and guidelines used by the division. The second was to match precisely the content of the QMS to the operational needs of the division. Figure 1 shows the structure that evolved for the QMS.

It was at this stage that the relationship between all of the key sources of information and guidance (such as the division business plans, local instructions and the PCH) became apparent. The QMS, rather than being a separate entity, actually consisted of all the elements shown in Figure 1. The portion of the QMS that had to be written specifically for the needs of the division, the Quality Management Handbook (QMH), served to link the other information together. The way in which this was achieved can be explained with reference to Figure 2.

The contents of the two volumes of the QMH, together with its interfaces to the rest of the quality management system, are explained in greater detail below.

The interfaces between the QMH and the documentation that forms the rest of the QMS, shown by the arrows in Figure 2, may appear to be straightforward. However, in practice, defining and agreeing the exact nature of these links proved extremely difficult. The document detailing the interfaces, which eventually became the guide to the QMS, was reviewed more than any other in the QMH. The importance of this document cannot be overstated as it was a vital precursor to setting the final scope of the contents of the QMH. Once the interfaces were settled, the final structure became apparent. With reference to Figure 2, the following is a brief description of each section in the QMH.

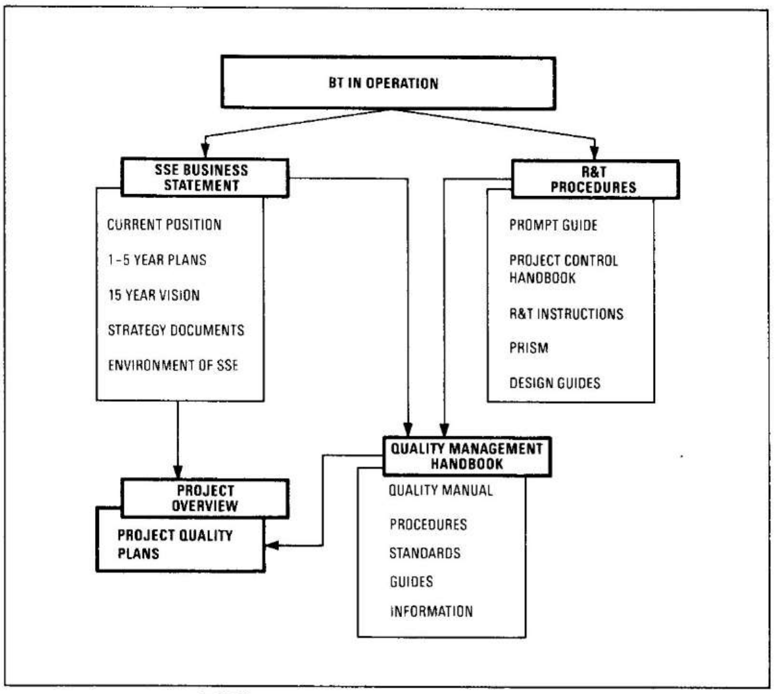

Figure 1—Components of the QMS

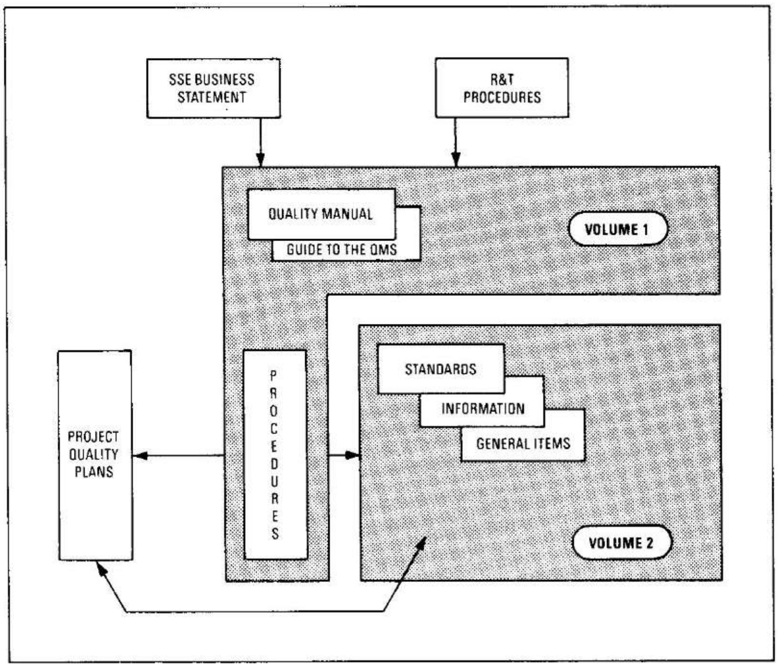

Figure 2—Structure of the Quality Management Handbook

The Quality Manual

This is the controlling document for the QMS. It contains the quality policy statements and describes the organisational structure. The greater part of the quality manual outlines the procedures used in the division to meet the requirements of ISO 9001.

Procedures

The procedures are the work instruction which detail what each task should achieve. There are 26 procedures in the SSE QMH covering such diverse subjects as configuration management, change control, asset registration and computer backup strategy.

Standards

These are the entries in the QMH which describe the criteria to achieve quality. There are currently nine standards, including a checklist for the conduct of audits, a skeleton quality plan and a glossary of terms used within the division.

Information

These documents give useful (and usually non-mandatory) information, often supporting a procedure or standard. There are five such documents of this type; for example, guidelines for document control and project status monitoring.

General Items

This is the repository for all instructions that have been issued to SSE staff. The reason for having this category is to control all relevant documents used within the division—not just those in the categories specified above.

The current version of the SSE QMH is contained in two standard A4 volumes. A copy is lodged with every manager and group quality representative within the division. The complete QMS is reviewed every six months, as required in the ISO 9001 standard.

AUDITS AS A MEASURE OF PROGRESS

The only way to check the progress of the installation and use of a QMS is to measure it. The principle is 'if you cannot measure it, then you are not in control'. The key metric for this measurement (used for ISO 9001) is that of the quality audit. The audit can be seen as closing the quality loop by finding problems, reporting them to the relevant manager and ensuring the issues are all cleared within agreed timescales.

The quality audits are only truly effective when they test the QMS in operation. It was some six months after an effective mass of procedures was in place before the audits became viable. Once the audit phase started in earnest, progress could be objectively tested. Independent assessment was provided by another BT department, the Birmingham QSM team, whose help and assistance proved invaluable. These audits enabled the production of a full list of the documentation required and a definition of all the interfaces to customers both within and outside BT. This was without doubt the low point in the project from the Quality Manager's point of view as there was a seemingly endless list of jobs that had to be done. A new-found ability emerged at this point—that of clearing rooms when looking for volunteers to produce procedures and clear audit problems.

The audits also provide an accurate picture of the division's performance against the QMS (for example, discrepancy between what is happening and what should be happening) as well as pointing out any inherent deficiency in the QMS itself. The audit programme began after a couple of false starts with two full audits of every project within the division. These audits were performed by the SSE quality team under the direct control of the Deputy Divisional Quality Manager. Once these audits had progressed to the stage of trapping most of the procedural problems, the next stage was to have pre-BSI audits performed by Birmingham QSM. These audits were against ISO 9001 to ensure consistency of the QMS with the accredited standards. The pre-BSI audit was a true 'drains up' audit, a harrowing experience which none the less improved the QMS (short term pain for long term gain). The results of the findings from these audits are shown in Figure 3.

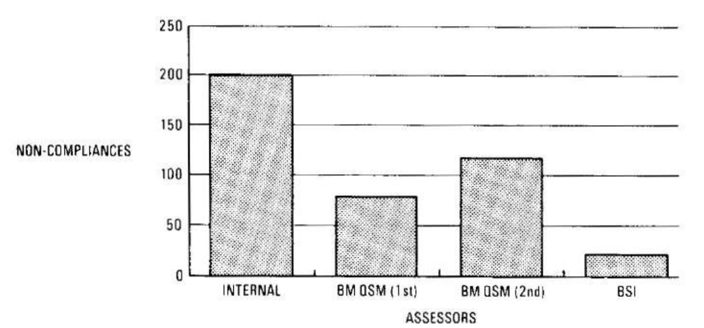

Figure 3—Result of assessments: number of non-compliances found at successive audits

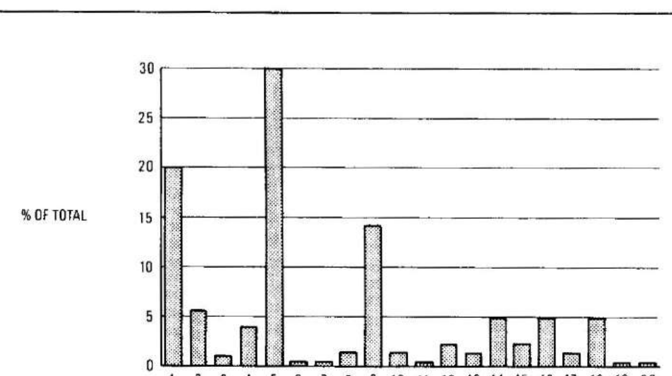

Figure 4—Result of assessments: percentage of non-compliances against ISO 9001 (Section 4)

This graph shows the fall in number of non-compliances against the time that the audits were performed. The fall in number is due to the removal of the major problems by corrective action following the audits of the QMS.

Figure 4 shows the percentage of non-compliances against the sections of the ISO 9001 standard. The major areas which were identified as requiring attention were:

4.1 Management responsibility
4.5 Document control
4.9 Process control

This profile would most likely be different for any other organisation. The essential purpose of the audits was to identify areas of weakness with respect to the standard and to initiate corrective action. After each audit, a new plan was produced, detailing what needed to be done, by when and by whom.

THE RUN-UP TO ASSESSMENT

The assessment and revision of the QMS took seven hard months. It was only after this period that a standard capable of satisfying the BSI was reached. In the final run up to the BSI visit, the audit programme was intensified by including an audit of the quality team by another division's quality team; this team provided us with a very tough audit which tested our QMS to its fullest extent (we are looking forward to the return match). Finally, the Birmingham QSM staff performed two pre-BSI audits before pronouncing the division ready to be assessed for registration.

The division then had a pre-assessment visit from two senior representatives of the BSI. At this meeting, the size of the assessment team was set at four people for four days. Formal agreement was reached on which quality assurance schedule (QAS) the division would be assessed against. The function of the QAS is to expand and define the words used in the ISO 9001 standard. Just before the BSI audit, Birmingham QSM gave the division a presentation on 'How to pass a BSI audit'. This presentation was videoed for staff who could not be present and all but five out of the division's 136 staff attended. As part of the final countdown to the assessment, every office used by the division was subjected to an accommodation audit. This included looking at fire extinguishers to see if they were in date and that any equipment's user manuals etc. were the latest issue. In short, any fine detail that the BSI assessors may find of interest and decide to explore.

THE BIG DAY

The BSI audit runs to a standard format, starting with an opening meeting in the morning and a closing meeting each evening at which any non-compliances would be passed to the quality team.

There are two types of non-compliances or discrepancies:

- minor, such as documents not signed etc., and
- major, where the QMS can be proved not to be working as specified.

According to the BSI, the ground for an assessment failure is one major non-compliance or sufficient minors to cast doubt on the effectiveness of the system.

The audit consists of setting up and following audit trails. A number of different approaches are used during the audit to establish these trails. One method is to start from the individual's job description and ask for responsibilities and accountability. Another is to start with the project or quality plan of the project on which the individual is working. The third method is to conduct a role-based interview with, for instance, the training officer, and to establish whether this section of the QMS is working as it should. The fourth technique is to perform a management-based interview. These interviews were performed by the lead assessor.

The object in each case is to prove to the BSI that you do what you say in a controlled manner. To test this, there is in each case frequent inspection for written evidence to back up what is said. These checks are invariably carried through to see that files are correctly updated, action points appropriately cleared etc.

Each of the BSI auditors is accompanied by a divisional guide whose function is to introduce the auditors and ensure full co-operation. As a basis for planning the audit, a map of the building and a full telephone list are usually required by the BSI auditors. The length of the interviews varied from 20 minutes to 2·5 hours. The BSI conducted 67 interviews in all, one of which was with a rather startled Business Operations Manager who was not in the division. By the end of four days, the BSI auditors had systematically analysed every aspect of the division's work. They had visited every office, storage area and computer room at least once. At the final meeting, we were given 30 days to clear the 23 minor non-compliances found over the four days. The BSI returned after the permitted 30 days to ensure all the non compliances were cleared.

Immediately after this follow up visit, the division received registration to BS 5750 Part 1: 1987 and ISO 9001.

BSI REGISTERED FIRM

British Telecom plc
Research & Technology RT 31
Registered Firm FM 2205

THE WAY AHEAD

Where do we go from here? We have proved we meet the minimum standard of ISO 9001. This means two things. First, the division is accredited as under control. Second, the procedures used within the division mean that the services provided can be judged against a predetermined level of quality. There are several further objectives that follow this, one being to make the quality system more user friendly. A second would be to extend the QMS to link together more closely project, financial and quality management. A third could be to produce a paperless QMS.

At present, SSE is undergoing a TQM drive and the link between ISO 9001 and TQM is an interesting one which has drawn many inquiries from the staff. A widely accepted model for describing this link is to draw the analogy with a clock mechanism: TQM is the key which tensions the main spring, the QMS is the pawl in the detent that holds the tension. ISO 9001

will enable us to hold the gains that the TQM program will bring.

The quality road goes on for ever; to paraphrase Winston Churchill, ISO 9001 is not the beginning of the end, but the end of the beginning. Now that a firm verified base is in position, further improvement can be made on the basis of measurement.

THE GOLDEN RULES FOR A QUALITY SYSTEM

This article has described the process by which SSE has attained quality registration. A number of key lessons have emerged in that process. The following points are an attempt to summarise the most important rules for installing a quality system:

(*a*) It must help people do their job.

(*b*) The QMS must reflect what you actually do, not what you think you do.

(*c*) Without senior management commitment you will not be able to install a successful QMS.

(*d*) You must get 'buy in' from the users of the system.

(*e*) The procedures you pick to write first will inevitably be the wrong ones.

(*f*) A critical mass is needed before any effect is seen.

(*g*) Keep the documentation short, simple and under control.

(*h*) When you audit you are auditing the QMS not the people. The auditor is not a policeman.

(*i*) The QMS must not just look inward, the interfaces to the rest of the world must be controlled.

(*j*) You need a 'bright morning star to follow'. The system must improve: if it remains static in a changing world it is actually going backwards[7]. The bright morning star is the future target.

(*k*) The most important rule is 'Quality is an attitude of mind, not a system'.

CONCLUSIONS

Quality is now recognised as one of the most important factors in commercial success. This is especially true in areas such as software engineering, where most of the output is essentially intangible. This article has described the general requirements of a quality management system capable of being registered to the recognised ISO 9001 quality standard. The steps taken by SSE to attain accreditation have been explained. Far from being an end point, this registration lays the ground work for total quality management within the division.

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References

1 STODDART, A. G. The Systems and Software Engineering Division. RT31 Front Office.
2 JACKSON, L. A. Software systems design methods and the engineering approach. *Br. Telecom Technol. J.*, July 1986, **4**(3).
3 International Standard ISO 9001.
4 BSI British Standard BS 5750, Part 1 (1987). Quality Systems—Specification for design/development, production, installation and servicing.
5 REDMILL, F. J., KIMPTON, R. I., and ACOTT, M. Quality—Experience with Departmental Purpose Analysis. *Br. Telecommun. Eng.*, July 1989, **8**, p. 92.
6 POULTER, A. The Research and Technology Project Control Handbook.
7 PETERS, T. The management of chaos. Pan Publications.

Biographies

Alan Stoddart joined British Telecom Research Laboratories in 1956 and during his career has worked on digital transmission, waveguide developments and digital switching. He is currently Head of the Systems and Software Engineering Division at BTRL. He is a Chartered Engineer and a Fellow of the Institution of Electrical Engineers and member of the British Computer Society. He initiated the drive to install quality systems within both SSE and R&T.

Mark Norris received his B.Sc. and Ph.D. degrees from the university of Glasgow in 1976 and 1979, respectively, before joining British Telecom Research Laboratories in 1980 to work on local network signalling systems and interfaces. His work since has encompassed implementation of the ISDN, high-speed local area networks and interface test equipment. He currently heads a Section researching into software maintenance. He is also responsible for divisional training and co-ordination of publications.

Peter Rigby joined BT in 1963 as an apprentice in the Blackburn Area. He has worked in a number of Areas as a radio interference officer and an efficiency engineer. He graduated from Newcastle Polytechnic in 1982 with a B.Sc. in Physical Electronics. His recent duties have all been concerned with quality and divisional support. He currently fulfils both these roles for SSE and has been the Divisional Quality Manager for the last year.

Validation Testing—Improving Product Quality

C. D. WILMOT, and P. J. WHITING†

The prototypes of a product must be validated prior to release to manufacture. Validation testing involves checking that the prototypes have the required functionality and meet the necessary hardware and environmental criteria. This article describes validation testing with reference to a typical prototype, a local area network (LAN) bridge. The article also highlights the generic features that designers should consider when producing a product, and describes possible verification techniques to be applied throughout a design.

INTRODUCTION

Quality is defined in British Standard BS4778 as:

> 'The totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs.'

This article outlines the principles involved in the validation testing of a product prior to submission to the chosen manufacturer. The article has been based on the authors' experiences of product testing, with the NetBridge product being used as an example. Validation testing is the independent assessment of a product which occurs after product development to determine the extent to which a product meets its specification and is fit for its purpose. It is an assessment of the quality of the product which identifies weaknesses or omissions in the design which may then be corrected.

The authors' group (Product Validation Group (RT5122) in British Telecom Research and Technology) was formed over 2 years ago and is part of a product assurance section whose mission is to test products throughout the product life cycle. Validation testing is more successful and cost effective when it forms part of an integrated product assurance approach. Other groups in the section specialise in software product assurance. Validation seeks to provide:

(*a*) an independent and cost effective assessment of products;

(*b*) detection of faults or omissions in the design prior to manufacture;

(*c*) identification of components in the design that could cause problems after release;

(*d*) characterisation of the software and hardware for sales to informed purchasers;

(*e*) a reduction in BT's product liability; and

(*f*) a single library of information concerning the standards and acceptance criteria that the product meets.

In order to cover the full scope of testing, the group has been split into two distinct teams to reflect the domains that must be addressed: the hardware and environment domain, and the functional domain. Throughout the article the term *feature* is used. A feature is a distinguishing characteristic of a software or hardware item, that may be tested. The term *feature* has been adapted from the IEEE 829 software test documentation standard. The hardware and environment domain includes a number of features that the product may need to meet. These are referred to as the *hardware features*; they are:

- Safety
- Electromagnetic compatibility
- Atmospheric environment
- Dynamic environment
- Regulatory approvals
- Index of protection
- Ergonomics
- Reliability
- Testability
- Maintainability and repairability
- Manufacturability
- Labelling
- Components selection
- Appropriate information in user and maintenance documentation
- Thermal design
- Conformance to standards

For some of the above features, the standards and other acceptance criteria that must be met are determined by the countries in which the customer wishes to market the product.

The functional domain also includes a number of features that the product may need to be tested against. The features considered pertinent to this domain are:

- Functionality

† IT Products, British Telecom Research and Technology

- Installability
- Interworking
- Performance
- Usability/ Reliability/ Maintainability
- Security
- Conformance to standards

Improvements in technology have led to products being designed with increasingly more complex functionality. Therefore, the amount of effort required to test this functionality has become significant.

The example product, the NetBridge, was an Open Systems Interconnection (OSI) Media Access Control (MAC) layer LAN bridge, developed by another group (RT5161). The NetBridge provided a bridging capability between two LANs, which could be ISO 8802/3 (formerly IEEE 802.3, Ethernet™ type) or ISO 8802/5 (formerly IEEE 802.5, token ring type) LANs. The bridging took place at the MAC sub-layer in layer 2 of the OSI model. Bridges act like filters so that only data on one LAN destined for the other is transferred onto the other LAN.

The bridge functionality included the operation of a spanning tree algorithm, which aligns with the evolving standard, IEEE 802.1 supplement D. The algorithm determined the behaviour of the bridge when used in a network with several bridges. The algorithm operated so that when, topologically, there was a choice of routes to transfer data between LANs, only one route would be enabled.

There were three variants of the NetBridge which allowed for bridging between the following LAN standards:

ISO 8802/3 and ISO 8802/3;
ISO 8802/5 and ISO 8802/5; and
ISO 8802/3 and ISO 8802/5.

The hardware comprised:

(*a*) an enclosure consisting of a plastic case, metal chassis, wiring harness and power supply;
(*b*) a printed board assembly (PBA) which provided the generic processing software, referred to as the *bridge control module*; and
(*c*) any two LAN interface PBAs. There were two types of LAN interface PBA, referred to as the *8802/3 PBA* and the *8802/5 PBA*.

The three NetBridge variants were obtained from the combinations of the two types of LAN interface PBA.

HARDWARE AND ENVIRONMENT TESTING

The particular hardware and environment features that a product is tested for depends on:

(*a*) the nature of the product,
(*b*) the countries in which the product is to be marketed, and
(*c*) the testing that the customer wishes to be done.

Choosing the features that will be tested for is the subject of a study by the team and for negotiation with the customer. This results in the production of reviewed test specification documents. In the case of the NetBridge, separate hardware and environment and functional test specifications were written. The team has since adapted the IEEE 829[1] software test documentation standard for use with testing systems comprising hardware and software. IEEE 829 test plans provide an overview of the features which will be tested and will not be tested for the target countries. The IEEE 829 test design specifications provide more detail. The test design specifications describe the standards that must be met and other acceptance criteria, for example, temperatures and field strengths.

The IEEE 829 standard has been adopted for the following reasons:

(*a*) it provides a formal means of recording in the documentation which features should be tested and which features should not and the reasons why;
(*b*) it provides a uniform documentation plan and methods of recording results for the products;
(*c*) the documentation plan specified by the standard may be incorporated into a test information management system; and
(*d*) the standard is one of a set of standards that have been adopted by the division as part of the drive towards BS5750 approval.

Where appropriate, some of the testing is sub-contracted to specialist test houses. For example, electrical safety was sub-contracted to the Quality and Reliability Centre (QRC), formerly the Materials and Components Centre (MCC). Electromagnetic compatibility (EMC) was sub-contracted to the EMC test group (RT5326) at British Telecom Research Laboratories, Martlesham Heath. When some of the work is sub-contracted, it is still the responsibility of the hardware and environment team to:

(*a*) co-ordinate the validation testing;
(*b*) liaise with the sub-contractors;
(*c*) arrange dates for testing given a limited number of prototypes;
(*d*) provide equipment and appropriate test environments;
(*e*) provide the detailed test specifications to the sub-contractors;
(*f*) observe testing when appropriate; and
(*g*) obtain the test reports from the sub-contractors, clarify points and report back to designers, primarily through the use of problem reports.

The hardware features are described in more detail below:

™ Ethernet is a trade mark of the Xerox Corporation

Electrical Safety

One of the most important aspects of equipment design that must be addressed is electrical safety. Equipment cannot be sold unless it meets a safety standard. In the UK, the appropriate safety standard for equipment such as the NetBridge is BS6204, which is based on the international standard IEC 435. The BS6204 standard is concerned with the electrical safety of data processing equipment. The standard includes some mechanical and flammability checks on the equipment.

D1921C is a BT safety standard which must be met for new and redesigned items of equipment that are to be maintained by BT. This standard places additional requirements on the equipment compared to BS6204. Probably the most important requirement that D1921C places on equipment concerns the provision of protective covers. The customer must state in the requirements specification how the product is to be serviced. D1921C states that if the product is intended to be serviced by BT engineers with the top cover removed, then electrical protective covers must be provided over all sources of hazardous voltages which could be touched during servicing.

Electromagnetic Compatibility

Electromagnetic compatibility may be subdivided into five areas; they are:

(*a*) radiated emissions,
(*b*) conducted emissions,
(*c*) electromagnetic immunity,
(*d*) conducted susceptibility, and
(*e*) electrostatic discharge.

Emissions from the product may cause interference with other equipment in the vicinity. Radiated emissions are electromagnetic emissions generated by the product and its connecting wires. Conducted emissions are electromagnetic emissions that are conducted into the wires connecting the product to other equipment. Conducted emission standards only require the measurement and limitation of the noise conducted from the product onto the mains supply.

If there are sufficient incident electromagnetic fields or there is sufficient noise present on the mains cable of the product, then the product will misoperate. Electromagnetic immunity describes the ability of the product to withstand incident electromagnetic fields. Conducted susceptibility describes the ability of the product to withstand incident noise on the mains cable.

Electrostatic discharge describes the susceptibility of the product to the fields generated by electrostatic discharges either directly to the product or in the vicinity of the product.

Within the EMC area, radiated and conducted emissions are of the greatest concern as there are mandatory standards and standards that are about to become mandatory. The two major industrialised nations that have mandatory emission standards are the USA and West Germany. The USA standards are embodied in the FCC Regulations; and the West German requirements are embodied in a set of VDE standards.

The European Norme for radiated emissions is EN55022. This will become mandatory for the whole of the EEC on 1 January 1992. This European Norme is implemented in the UK as BS6527.

There are no mandatory national or international standards for electromagnetic immunity, conducted susceptibility or electrostatic discharge. There is a non-mandatory international immunity standard IEC801, however, for equipment for use in BT; BT standards are normally used. These standards are:

D10100 and D10110 (electromagnetic immunity standards);
D10400 and D10410 (conducted susceptibility standards); and
D10700 and D10710 (electrostatic discharge standards).

Atmospheric Environment

Atmospheric environment tests may be divided into two areas:

(*a*) tests that demonstrate that the product will operate within a specified temperature and humidity range; and
(*b*) tests that demonstrate that a product can be stored within a specified temperature range.

Temperature cycling in a climatic chamber is used to simulate operation and storage conditions. For tests on the NetBridge, the following test standards were used:

BS2011: part 2.1Bd,
BS2011: part 2.1Dd, and
BS2011: part 2.1Ad.

For tests for the storage of the NetBridge, the standard BS2011: part 2.1N was used.

Dynamic Environment

The purpose of dynamic environment tests is to find deficiencies in the mechanical fixings. These include fixings in the enclosure, the securing of the boards, and the securing of the components to the boards. Without these tests, problems may occur in normal operation, or during transportation. For the NetBridge, three types of dynamic environment tests were used. The tests were sinusoidal vibration tests (to BS2011 part 2.1Fc), random vibration tests (to BS2011 part 2.1Fd) and bump tests (to BS2011 part 2.1Eb). The tests were chosen to reveal problems associated with vibrations of a harmonic nature, vibrations of a random nature and vibrations associated with repetitive shocks. There are other tests that could be used for a product; for example, drop and topple and free fall.

Regulatory Approvals

Regulatory approvals are concerned with the connection of equipment to public networks. The standards which need to be met are undergoing change. A set of mandatory European standards, the *Normes Européènes de Télécommunications* (NET) standards, are being introduced to replace national mandatory standards. The UK is one of the countries that has agreed to be bound by these standards. Apart from the functionality of the equipment, the NET standards and existing national standards affect the provision of interfaces to the public networks and the need for electrical isolation barriers.

Index of Protection

Enclosures should be designed so that they provide appropriate protection to the electronic equipment. Standards exist that classify the protection provided by enclosures. The UK standard is BS5490, which is identical to the international standard IEC529. The standards specify protection classifications that include the following:

(*a*) protection against solid objects of varying sizes;
(*b*) limited dust protection;
(*c*) dust-tight protection;
(*d*) protection against dripping, spraying or splashing water;
(*e*) protection against heavy seas;
(*f*) protection against immersion; and
(*g*) protection against submersion.

Ergonomics

Ergonomics is the study of the efficiency of persons in their working environment. The efficiency of individuals when they handle information technology equipment is affected by the design of the equipment. For a product like a work station, the design is affected by issues concerned with comfortable sitting and viewing posture.

For a product like the NetBridge, typical ergonomic issues that need to be considered are whether:

(*a*) the presentation of the product is pleasing, conformant to relevant style guides and appropriate for the use;
(*b*) the types of display used are appropriate (examples are light emitting diodes (LEDs), digital displays, auditory displays and passive displays like instruction panels);
(*c*) the high-priority displays are in the prime visibility zone;
(*d*) the prioritisation and the presentation of the displays are correct;
(*e*) the visibility of all displays is good and the viewing comfortable;
(*f*) the displays are too crowded;
(*g*) the locations of the displays are standardised; and
(*h*) there are requirements for additional passive displays to enhance the active displays.

Reliability

During validation, a prediction of the reliability of the product should be made. Although reliability predictions are imprecise, they do:

(*a*) provide an indication of the potential of a product to meet the customer's reliability requirements;
(*b*) enable an assessment to be made of the life cycle costs;
(*c*) establish which components or areas in the design most affect the reliability of the product; and
(*d*) provide a basis to make a trade-off between reliability and maintainability.

There are different methods of making reliability predictions. The methods used depend on the complexity of the product. If a redundancy mechanism is designed into the product, then a method like fault tree analysis may be used. For a product such as the NetBridge, only a parts stress count analysis was necessary. This may be based on the information in the BT Handbook of Reliability Data. The handbook allows component reliability predictions to be made based on:

Complexity
Pins on the package
Package type
Junction temperature
Component type and technology
Maturity of the technology
Component quality
Operating environment

Testability

The purpose of design-for-test is to include attributes in the design to improve in-circuit testing for manufacture and repair. Design-for-test seeks to:

(*a*) improve the controllability and observability of areas of the circuits; for example, by providing extra test observation points and inputs which can disable feedback loops;
(*b*) provide fault location to sufficient accuracy to allow repair to take place;
(*c*) reduce test development time and costs; and
(*d*) reduce the time taken to test a product.

The validation of design-for-testability involves an analysis of the design to check that it includes appropriate design-for-test attributes. The testability standard against which designs are assessed is the Testability Manual[2]. The NetBridge included design-for-test attributes.

Maintainability and Repairability

Maintainability and repairability validation involves checking that these two issues have been

considered in the design of a product. This may be against a maintainability and repairability specification. Such a specification would consider:

(*a*) the man–machine interfaces which must be provided; for example, LEDs and RS232 ports;

(*b*) the diagnostic statistical information which must be collected when a failure occurs;

(*c*) the scope of the diagnostic test cases that should be provided for use by system management, field repair, repair centres and manufacturers; and

(*d*) the least replaceable assemblies (LRAs). An LRA is a field replaceable module at which local fault diagnosis ceases and direct replacement occurs. For example, this could be a PBA.

Manufacturability

The validation of manufacturability involves testing the product to determine if there could be problems in the manufacture. It does not include checking the adequacy of the documentation to be supplied to a manufacturer. Some aspects of manufacturability appear in other features; notably, testability, component selection, labelling, maintainability and repairability. The extent to which it is possible to assess the manufacturability depends on whether the manufacturer has been selected. There are some manufacturability rules which are independent of the manufacturer. Examples of the issues that these rules cover are:

(*a*) orientation of components to allow for automatic placement;

(*b*) component labelling on boards to make visual examination easier;

(*c*) avoidance of hand assembly;

(*d*) avoidance of components and component packaging styles that may give a low product yield; and

(*e*) selection of the soldering method (wave soldering versus reflow soldering).

When the manufacturer is known and a manufacturer's design specification is available, then a more detailed assessment may be made.

Labelling

The labelling that a product requires will depend on the nature of the product and the markets in which the product will be sold. The parts of a product that typically require labelling are enclosures, boards, read-only memories, and programmable logic devices (PLDs). Labelling may be necessary to satisfy requirements for safety, EMC, regulatory requirements, ergonomics, testability, maintainability and repairability, manufacturability, change control, and to demonstrate conformance to standards; for example, the British Standards 'kite' mark. Some of the labelling is necessary to meet legal requirements; for example, in the area of safety. It is also necessary to provide appropriate logos on the enclosures and boards, and product name labelling.

The type of labelling chosen must be appropriate for the information that the label must convey and the durability required. Possible choices are labels that are printed on, stuck on with adhesive, screwed down, and etched on.

Validation of the labelling involves checking the labelling against a checklist and by reference to appropriate standards, such as safety standards.

Component Selection

Validation of the component selection involves reviewing components lists. This is to check that the most appropriate components have been used. Some of the aspects that should be covered are:

(*a*) availability;

(*b*) cost;

(*c*) quality (if there is a need to specify components that meet quality system standards; for example, BS9000, CECC, or IECQ);

(*d*) whether preferred suppliers or distributors have been used;

(*e*) whether second sources are available;

(*f*) whether the component packaging is appropriate;

(*g*) whether the packaging style conforms to a standard;

(*h*) whether there are any problems reported by evaluation bodies like QRC and STACK (STACK is a body that reports on component problems identified by subscribing product manufacturers);

(*i*) whether the component is a preferred part;

(*j*) whether the component can be used for new designs or maintenance or whether it is about to become obsolete; and

(*k*) whether the number of different components used in the design has been minimised.

Appropriate Information in User and Maintenance Documentation

It is necessary to test that there is appropriate information in the user and maintenance documentation. This involves checking the accuracy of the hardware maintenance procedures, and ergonomic aspects like the documentation presentation and readability. Also, it is necessary to provide statements in the user and maintenance documentation to meet standards in the areas of EMC, safety and regulatory approvals.

Thermal Design

Thermal design has become more important because of the increasing packaging density of many boards and the increased heat dissipation of devices as they have become more complex. A good thermal design ensures that the components in the product remain within their opera-

ting specifications under the specified extremes in ambient temperature, whilst ensuring that the solution is cost effective and that the reliability is not compromised. During the design stage, thermal design rules should be applied and a thermal modelling obtained if possible.

The typical validation methods used to check the thermal design are infra-red photography and thermocouples. The purpose is to ensure that the thermal design is adequate, and, if not, to allow the hot zones to be identified and eliminated by modifying the placement of components. In some cases, forced air cooling may be necessary.

Conformance to Standards

There are two aspects to this feature. For some in-house designs, it is desirable to obtain a conformance certificate from a standards body as part of the validation work. This gives the product customer security against possible legal action and allows the manufacturer to label the product as conforming, possibly enhancing sales. A typical example is safety.

In some cases, it is necessary to check that a bought-in product has been tested for conformance and arrange testing if not. In either case, copies of the certificates of conformance or the test reports need to be obtained and stored in the validation library.

FUNCTIONAL TESTING

The functional domain covers the aspects of functional behaviour; performance; and interworking, or interoperability. Before validation can proceed, the software used in a product should have been component tested and module tested by its developers. The functional team view the product under test as a 'black-box' and are only concerned with testing the external interfaces and the external behaviour of the product. The internal workings and interfaces are not investigated by the functional test team, unless they are visible in some way to users. White box testing should be done earlier in the design.

Functional Behaviour

The functional behaviour is perhaps the most difficult aspect to test. The criteria against which the functional behaviour should be tested must be chosen with care. The criteria must not only be acceptable to the functional team, but must be acceptable to the customer.

The most commonly used criteria are:

(*a*) the customer's product requirement specification;

(*b*) the developer's product functional specification;

(*c*) user manuals and other user documentation, although these are not usually available when testing early prototypes; and

(*d*) recognised standards; for example, ISO OSI, Open Network Architecture (ONA) and GOSIP-T standards.

User manuals must be validated in their own right to ensure that they agree with what the product does do and with what the product should do. Particular attention is paid to the error messages.

Testing for conformance to a recognised standard is the most rigorous form of functional validation. A conformance test report and certificate for a particular standard is often required for marketing purposes; however, this can be costly. Earlier in the product development life cycle, the functional team may undertake *confidence testing*. Confidence testing is where a reduced set of conformance tests are performed on a product to give a level of confidence in the product, usually at a lower cost than a full conformance test. Detecting any serious non-conformance potential early in the design process reduces the risk of extensive rework being necessary. Such rework can cause market windows to be missed.

There are several problems concerned with testing for conformance to a standard:

(*a*) quite often technology moves on beyond the standard;

(*b*) by the time a standard is issued, many implementations are usually in the market-place which may not quite meet the standard; and

(*c*) many implementations do not just meet a standard, but they also provide extensions to it, which may or may not become improvements. These improvements may infringe the letter of the standard itself. Standards have lifetimes of several years. Most ISO standards have a lifetime of four years before they are reviewed, and improvements may then be incorporated. A lot can happen in the market-place in four years.

Performance Validation

Performance validation is concerned with comparing the actual behaviour seen or measured to the requested behaviour as defined by a specification or standard usually under extreme traffic conditions. Examples of this are:

(*a*) the throughput rates of an OSI product at maximum network loading;

(*b*) transaction failure rates of a network or network node at maximum loading; and

(*c*) tolerance of a product to invalid input stimuli under conditions of high traffic.

Interworking

Perhaps the most important aspect of functional validation is testing for interworking. This is particularly true if a set of products is being validated. The first validation of early prototypes will probably be the first time that someone independent of the development team

exercises the products, and the first time that the product set is integrated and fully exercised.

Interworking, as its name suggests, means testing to asertain whether the products within a product set work and interact correctly with one another, and whether the product(s) under test interwork correctly with similar products from BT or from other manufacturers.

Experience has shown that the claim of conformance to a standard does not guarantee that a piece of equipment will interwork with another piece claiming the same conformance.

Interworking testing is based upon a list of equipment with which the product is to be tested for compatibility. The list has to be for the markets that the product is to be aimed at.

The example product, the NetBridge, was designed to be conformant with the following standards:

ISO 8802/3 CSMA/CD LAN access method (for example Ethernet™), and

ISO 8802/5 Token Ring LAN access method.

The Netbridge was also designed to align with the evolving IEEE 802.1 (Part D) MAC Layer Bridges standard.

The team carried out the testing of the network spanning-tree algorithm defined in IEEE 802.1 (Part D) and the conformance testing of the CSMA/CD and token ring LAN access (MAC) layers. In order to test the physical layers, the services of an outside testing house were sought. Other functional tests were developed for the NetBridge to support testing for hardware features such as electromagnetic compatibility and atmospheric environment. When testing for these, it is necessary to monitor the operation of the product.

REPORTING RESULTS

There are three methods of making problems visible to the designers:

(*a*) problem reports,

(*b*) test reports from external test centres, and

(*c*) end-of-validation-stage reports.

For each problem identified, including problems identified in the test reports, a problem report is produced. A problem report highlights an individual problem, describes the problem in detail and, if possible, suggests fixes. The problem report provides a clear and focussed interface to the designers; it contains information that might otherwise elude the designers if they were to just use the test reports. Test reports tend to be written in the jargon of the test centre and not from the point of view of the designer. Problem reports also allow individual problems to be tracked; the reports are used in design reviews.

For the NetBridge, problems were assigned one of three priorities: high, medium or low. Choosing the priority was sometimes difficult and did not always communicate the severity and nature of the problem to the designers and the customer. For these reasons, the group is now using a more meaningful set of problem classifications: sales affecting, service affecting, and service improving.

At the end of validation, hardware and environment and functional end-of-stage reports are produced. These summarise the tests that were performed, give reasons for any that were not, reference the problem reports and state whether problems have or have not been cleared. The decision to end validation is taken in consultation with the designers and the customer and using Prompt procedures. Prompt is a project management methodology. Ideally, at the end of validation, all the problem reports with sales affecting and service affecting classifications will have been cleared. Also, those reports with a service improving classification should have been examined.

Monitoring progress on validation activities is achieved using Prompt procedures such as checkpoint meetings.

CHANGE CONTROL

The design of the prototypes used may change subtly throughout validation. Designers may be allowed to make minor upgrades to the software and hardware, or have to make repairs. To ensure that tests are repeatable, each prototype must be given a unique build number. The sheet describing the build contains information such as:

(*a*) the location of the PBAs,

(*b*) the configurations of the jumpers and switches on the PBAs,

(*c*) the version numbers for the software,

(*d*) the version numbers for the PLDs, and

(*e*) the version number codes printed on interface integrated circuits; for example, LAN interface devices.

Whenever a prototype is given to the designers for modification, it must be booked out. When it is returned, it must be booked in and a new build number issued simply to ensure that the test environment can be re-created. After each change to the prototypes, an assessment must be made as to which tests must be repeated.

IMPROVING VALIDATION

Validation testing may be improved by:

(*a*) better use of validation checklists;

(*b*) tools that make problem reporting easier and produce summaries of problem reports and problem progression;

(*c*) regression testing tools that can run the same tests on different prototype builds and can check the results for consistency;

(*d*) automated assistance in the selection of test subsets for regression testing;

(*e*) build control tools which are shared with the designers; and

(*f*) the development of techniques for testing distributed systems.

PRODUCT ASSURANCE THROUGHOUT THE LIFE CYCLE

Product assurance is concerned with testing the product throughout the design. Validation testing is a stage in product assurance that occurs at the end of the design. It is more efficient to consider the aspects of the design at the earliest opportunity. Making modifications after the prototypes have been produced can be costly and makes inefficient use of human resources. Therefore, the group is working on methods of providing independent verification tests early in the design as part of the product assurance section. These methods will work in conjunction with the division's quality procedures for hardware design to assist in the achievement of high product quality.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the following people who are members of the validation section: Mr. S. A. Birchall, Mr. R. A. Reynolds, Mr. N. S. Day, and Mr. S. Chalklen. They also wish to acknowledge the work of members of the NetBridge design group, RT5161, which is led by Mr. W. Bunn.

References

1 ANSI/IEEE IEEE Standard For Software Test Documentation, Std 829, 1983.

2 MAUNDER, C. M. The Testability Manual. RT5664.

Biographies

Christopher Wilmot is an Executive Engineer in RT5122. He read joint honours Electronic Engineering and Physics at the University of Birmingham. On graduating in 1981, he went to work for Plessey Telecommunications Limited. In his first year with the company, he studied for an M.Eng degree in Microelectronic Systems at the University of Liverpool, which he received in 1982. He later worked on the design of call logging systems. He joined British Telecom Research Laboratories in 1984. Until 1987, he worked on the specification and design of distributed systems and voice and data products. Since then he has worked in the area of hardware and environment validation and product assurance.

Paul Whiting is an Executive Engineer in RT5122. He read Mathematics at the University of Birmingham, graduating in 1980. He remained at Birmingham and went on to receive an M.Sc in computer science (1981), and continued working for a Ph.D until 1984. He spent his first few years after joining British Telecom Research Laboratories working on a digital signal analysis and display tool, STACE. Since then, he has worked in the area of OSI and distributed systems validation and conformance testing. He is a member of the British Computer Society.

Neighbourhood Engineers

J. L. C. ELLIOTT†

Neighbourhood Engineers provide friendly, informal, practical and committed support to the daily life of their schools. This scheme has been developed by The Engineering Council to improve the understanding of engineering and develop an awareness of the important part it will play in the lives of young people now attending secondary schools.

INTRODUCTION

Modern engineering is of paramount importance to the wealth and well-being of the nation. Engineers have, for many years, been concerned to carry this message into schools. However, these efforts lacked co-ordination and the long-term personal contact required to drive the message home. The Neighbourhood Engineers scheme has been designed by The Engineering Council to overcome these weaknesses and offers a unique opportunity to match the resourcefulness of registered engineers with the needs of individual schools. Local enthusiasm is harnessed and the scheme builds on good practice already established.

ENGINEERING IN EVERYDAY LIFE

Engineering has a critical influence on virtually every part of our everyday life, from the clock-radio which marks the start of our day, through the cooking of our breakfast, our journey to work, the equipment we use at work, leisure activities to the light we switch off as we return to sleep.

Engineering has tremendous scope and is made up of many different branches. This fact was the real driving force behind the formation of The Engineering Council. One of the weaknesses of engineers in this country used to be the large number of bodies each claiming to speak for the engineering profession.

Engineering, being our major wealth creation industry, with such an important role in our daily lives, needed a single voice to ensure it could speak with conviction with government, industry or the academic world. It is through The Engineering Council that electrical engineers have been able to link with structural engineers, chemical engineers, mechanical engineers, agricultural engineers, civil engineers and so forth to make Neighbourhood Engineers a practical reality which is having a real impact on the young people in our schools.

† The Engineering Council South West Regional Organisation

THE ENGINEERING COUNCIL

The Engineering Council was established by Royal Charter on 27 November 1981 and its aims are to develop and promote, for the public good and the well-being of the national economy, all aspects of UK engineering by:

- increasing awareness of the essential and beneficial part engineering plays in all aspects of modern life;
- spreading best engineering practices to improve the efficiency and competitiveness of UK business;
- stimulating and leading discussions aimed at reaching decisions on the standards of education, training, retraining and experience necessary to meet defined engineering competence criteria;
- advancing engineering knowledge through education and training;
- ensuring, by direct action and encouragement, a sufficient supply of registered Chartered and Incorporated Engineers and Engineering Technicians;
- co-operating with, and where appropriate co-ordinating the work of, any organisations, groups or individuals whose activities have an engineering dimension.

The Engineering Council, an independent body, comprises 24 members and the chairman, Sir William Barlow, F.Eng. They are required to provide a balance between engineering interests in industry, the professional institutions and academia. The Chairman and at least two thirds of the other members must be Chartered Engineers, and at least one half of the members must have experience as employers or managers of practising engineers.

The Council, which is financed mainly by registration fees and Industry Affiliates' fees and by receipts from special projects undertaken for other bodies, has a small executive led by Mr. Denis E. Filer, TD, F.Eng. as Director General. It has 300 000 engineers and technicians on its register, the help and advice of more than 260 Industry Affiliates who include most of the leading companies in the country involved in

engineering and the support of 47 professional engineering institutions. The institutions work with the Council and together they set the standards for qualification and accredit courses for engineering.

THE ENGINEERING COUNCIL REGIONAL ORGANISATIONS

Nineteen Engineering Council Regional Organisations (ECROs) have been established throughout the UK (Figure 1) to promote the objectives of the Council in the Regions. The author is a member of the Engineering Council South West Regional Organisation (ECSWRO) serving Avon, Gloucestershire, Somerset and North Wiltshire. ECSWRO gives considerable support to its Careers and Education Committee which develops school/industry links. Groups of engineers in each of the four counties in ECSWRO have formed County Panels to co-ordinate activities in each particular county. Over the past two years, support has been given to the development of Neighbourhood Engineers and the scheme is now being extended to cover all secondary schools in the South West.

Figure 1
The Engineering Council Regional Organisation

REGION NUMBER AND NAME	POSTCODES IN REGIONS (FIRST TWO LETTERS)
1. SCOTLAND WEST	ZE KW PA PH FK G KA ML DG IV
2. SCOTLAND EAST	AB DD KY EH TD
3. NORTHERN IRELAND	BT
4. NORTHERN	CA NE DL DH SR TS
5. NORTH WEST	LA FY PR BB WN BL OL WA M SK CW ISLE OF MAN
6. YORKSHIRE	BD HG YO HX HD WF S DN HU LS
7. MERSEYSIDE & NORTH WALES	L CH LL SY
8. SOUTH WALES	SA LD CR NP
9. MIDLANDS	ST TF WV WS B DY WR CV HR
10. EAST MIDLANDS	DE NG LN LE NN
11. EASTERN	PE CB NR CO IP SG CM EN IG RM SS
12. THAMES VALLEY	RG SL HA UB TW
13. CHILTERNS	OX HP MK LU WD AL
14. KENT & SUSSEX	RH BN TN BR DA ME CT
15. SURREY	KT GU CR SM
16. SOUTHERN	SO PO DT SP BH
17. SOUTH WEST	BS SN BA TA GL
18. DEVON & CORNWALL	EX TQ PL TR including ISLES OF SCILLY
19. LONDON CENTRAL	E EC N NW W WC SW SE

NEIGHBOURHOOD ENGINEERS OBJECTIVES

The aim of Neighbourhood Engineers is to provide young people in secondary schools, their parents and teachers with a friendly and informal source of practical support on all matters relating to engineering, including cross-curricular projects to help teachers deliver the National Curriculum.

A good understanding of engineering will be developed together with awareness of the important part it will play in their lives.

METHOD OF OPERATION IN THE SOUTH WEST

The first project to get underway in the South West was at Broadlands School in Keynsham where much of the ground work was done in developing the scheme. Broadlands is a fully comprehensive maintained school for boys and girls in the age range of 11 – 18 years. The number on the role was 858 which included a sixth form of 52. Broadlands provided every opportunity to test activities involving every category of pupil. An outline of the scheme which was developed follows:

Before any schools are approached, it is important to present the scheme to the Science and Design Technology Advisers in the appropriate Local Education Authority. Experience has shown they will welcome the scheme with open arms and will give it their full support. The Director of Education is then introduced to the scheme and a letter of support from him/her to the Headteacher of each school being invited to join the scheme clears the way for efficient introduction at each school.

The scheme is operated by a group of locally residing/working engineers. These engineers will serve their chosen school over a period of at least two years—a personal relationship with the pupils, teachers and parents can be established on this basis.

Wherever practicable, a team of five neighbourhood engineers will serve each school. The ideal team will be:

Engineering Technician
Incorporated Engineer
Chartered Engineer
Retired Engineer
School Co-ordinator

Pupils will aspire to work at all levels in the engineering profession and so the first three members are appointed to give first-hand advice from their own current experience.

The new General Certificate of Secondary Education (GCSE) Design and Technology syllabus requires each pupil to undertake a special project which is assessed to form part of the final

grade. Teachers welcome the expertise of engineers in the classroom to give pupils undertaking these projects specialist advice. Careers teachers endeavour to make pupils aware of opportunities which exist in engineering for a satisfying and rewarding career and appreciate the first-hand experience of engineers in their lessons. To meet these needs, at least one member of the team needs to be available during school hours and a retired engineer is invaluable in this situation.

Each team will have a School Co-ordinator who will have particular responsibilities:

(*a*) being the focal point for communications,
(*b*) forming the team and initiating replacement of members of the team if this becomes necessary,
(*c*) convening meetings of the team, and
(*d*) introducing new initiatives.

The team should cover a range of disciplines and include both male and female engineers where possible—many more ladies are needed in the engineering profession.

Briefing packs have been produced to help the School Co-ordinator become familiar with the scheme and make him/her aware of all the resources available in terms of people and materials. Each County Panel has a County Co-ordinator for Neighbourhood Engineers who is there to help the School Co-ordinators and put them in touch with other people, such as specialists in the various Institutions, and to discuss the scheme when presenting the briefing pack. A wide range of material resources has also been assembled to support the neighbourhood engineers. These include display stands and lighting equipment for careers conventions, a wide range of careers leaflets covering every aspect of engineering, portable overhead projector, 35mm slide projectors, videos, video camera/recorder and industrial visits lists.

Once the School Co-ordinator has been recruited, briefed and built a team, then is the time to make the first approach to the school. Experience has shown that schools are delighted to become involved with the scheme and so there is little risk in building the team first. With this approach, we can always deliver and the scheme can get off the ground much earlier.

The initial meeting with the school should always involve the Headteacher. It is important scheme of which he should be aware and be willing to give his full support and commitment. For the same reasons as the need for a School Co-ordinator for the neighbourhood engineers, it is important to have a Teacher Co-ordinator. There are several science teachers in each school, for example, who should be involved. There are also teachers from the Design and Technology Department, Careers Department and so forth who should become involved. The Headteacher is therefore asked to appoint a Teacher Co-ordinator at the initial meeting.

Most schools are able to identify a number of ways in which neighbourhood engineers may be of assistance to their individual school. The scheme will get off to a successful start if the Teacher Co-ordinator is invited to list these in order of priority and the neighbourhood engineers then do their best to meet these needs before going on to offer activities which they suggest.

Once the scheme has been in operation for a few months, it is good to introduce new initiatives. Contact with other School Co-ordinators is useful at this stage. Experience has shown that bringing together all the School Co-ordinators in a given county to share ideas at a meeting every six months or so is an effective way of sharing experience. It also offers the opportunity for invited speakers to bring the engineers up to date with developments in the world of education.

NEIGHBOURHOOD ENGINEERS ACTIVITIES

As Neighbourhood Engineers develops and more schools become involved with the scheme so the range of activities grows. Some examples of the services provided by neighbourhood engineers are:

- Provision of up-to-date information on engineering as a career through a variety of channels—careers conventions, talks to groups of pupils expressing an interest in engineering, open days, careers counselling service, and so on.

- Encouraging the school to take advantage of The Engineering Council's 'Opening Windows on Engineering' scheme. Here a young engineer tells a class-size group of pupils about his/her day-to-day work, about specific problems or projects, and seeks to involve the pupils. The range of topics is wide and the object is to talk for about 40 minutes about the job the engineer does, its challenges, the problem-solving, the team-work and the creativity, crossing the barriers between science, technology, business studies and English. Each 'Window Opener' undertakes a short training programme. The training assures the quality of the speaker going into schools and serves as a form of professional development for the engineer.

- Support for engineering clubs (Figure 2)—rather different from scientific societies.

- Help with project work linked with the National Curriculum and the GCSE syllabus (Figure 3).

- Promotion of entries to 'Young Engineers for Britain'. This is an annual competition organised by The Engineering Council and funded by industry and commerce with prizes sponsored by industrial, commercial and professional organisations. It aims to encourage young people to undertake engineering project work and to

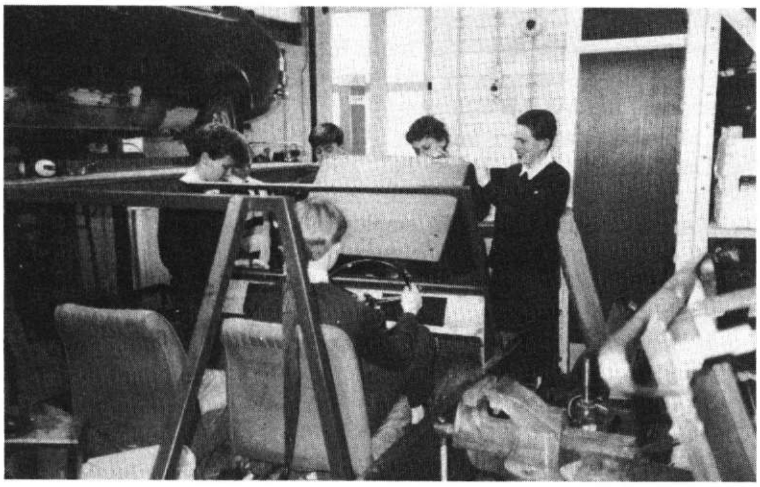


Figure 2—An engineering club in action

Figure 3—A neighbourhood engineer discussing a structural engineering project with pupils at Broadlands school

strengthen links between education and industry. Prizes are awarded at all regional competitions. At the national final, the overall winning entrant receives the prestigious title of Young Engineer for Britain and a trophy to keep. Many entrants have gone on to make their inventions a commercially viable product.

• Providing up-to-date examples of modern technology for use by teachers in the classroom.

• Arranging activities for girls and providing an opportunity for 'hands on' experience of new technologies. This is part of WISE (Women into Science and Engineering), a campaign to encourage more girls and women to consider careers in science and engineering. A WISE bus comes to the school equipped with facilities for work in mechanisms, micro-electronics, pneumatics, microprocessors for control and communication.

• Organising engineering games such as Telecom Link developed by British Telecom and the Institution of Electrical Engineers.

• Arrangements for industrial visits.

• Linking schools with local companies—acquisition of materials and equipment such as PVC duct, stepper motors, integrated circuit boards, oscilloscopes; access to modern computer-aided design facilities. All these services are at little cost to the companies (off-cuts, items just outside their specification but acceptable for school activities, outdated items from a commercial view-point) but of considerable value to schools with budget restrictions.

• Increasing awareness of engineering for all pupils at special events or using an engineering audio-visual roadshow developed by ECSWRO for large groups of pupils.

• Provision of work experience and job shadowing opportunities for pupils.

• Advising pupils who wish to select a suitable degree course to match their interest and long term aspirations in a specialist field such as telecommunications engineering.

• Serving as school governors—several neighbourhood engineers have been invited to become governors and are using their abilities to the full in the management of their schools.

• Helping the teachers themselves obtain industrial experience through secondment and in-service training.

• Advising design and technology teachers setting-up new facilities for teaching technology.

• Supporting teachers at meetings with pupils and their parents at evening functions such as the third-year GCSE options consultation stage.

• Forming a panel to answer questions on careers opportunities in engineering.

• Developing activities for pupils on a theme relating to an industrial visit.

• Linking teachers with specialists to help improve the teacher's understanding in new fields of technology they have been asked to teach and keeping subject teachers informed of developments in engineering.

RECRUITMENT OF NEIGHBOURHOOD ENGINEERS

The effectiveness of the scheme depends on the enthusiasm of the engineers taking part.

The recruitment of neighbourhood engineers can be achieved in various ways. Suggestions, in order of preference, are:

(*a*) by an open letter to registrants circulated with The Engineering Council Newsletter produced by the ECRO,

(*b*) presentations at local meetings of the various Institutions active in the region, and

(*c*) letters addressed to registrants in the neighbourhood of the school using up-to-date data handling equipment.

In the South West, School Co-ordinators have been recruited by using the first two methods alone. The School Co-ordinator usually has friends and colleagues who he/she invites to join the team. The Project Manager has access to a list of all registrants resident in the region in the form of a computer data base. If the postal code of the school is entered, the computer can list those registrants living in the neighbourhood of the school. Armed with this information the School Co-ordinator can make personal approaches to selected registrants in the knowledge of their expertise and registration (Eng.Tech./I.Eng./C.Eng) and so build a well balanced team.

PROGRESS AND FUTURE PLANS

In the South West, there are 231 secondary schools and, during the past year, neighbourhood engineers teams have been established to serve 79 of these schools. At no stage has there been a shortage of volunteers and this has been most encouraging. The aim is to link every pupil in the Region with Neighbourhood Engineers.

The scheme was begun in Devon and Cornwall, South Wales and the South West and each of these Regions were left to develop the scheme in their own way. Based on their experience, national guidelines have been prepared and the scheme is now available in four more Regions: Merseyside and Cheshire, Kent and Sussex, East Scotland and the Northern Region.

British Telecom is an Industry Affiliate of The Engineering Council and has given the scheme considerable support. At the individual level, many British Telecom employees are serving as neighbourhood engineers. Many more are required—there are 6000 secondary schools across the country.

Additional informational about Neighbourhood Engineers can be obtained from John Elliott, C.Eng., Telephone: 0272 392728, for engineers resident in the South West; or for those living in the Regions mentioned above, please contact Tim Maskell, I.Eng., The Engineering Council, 10 Maltravers Street, LONDON WC2R 3ER; Telephone: 01-240 7517.

Biography

John Elliott is Project Manager Neighbourhood Engineers in the South West Region. He has many years engineering experience, and is a Chartered Engineer and a Fellow of the Institution of Electrical Engineers. In British Telecom's Severnside District, he was District Engineer. During the past two years, he has worked for a Post Graduate Certificate in Education with Brunel University and has taught Physics and Technology in Avon Secondary Schools. This dual experience is invaluable in supporting Neighbourhood Engineers in the South West Region.

THE ENGINEERING COUNCIL

Neighbourhood Engineers

Development of Centrex within BT Severnside District Service PBX

S. POWELL†

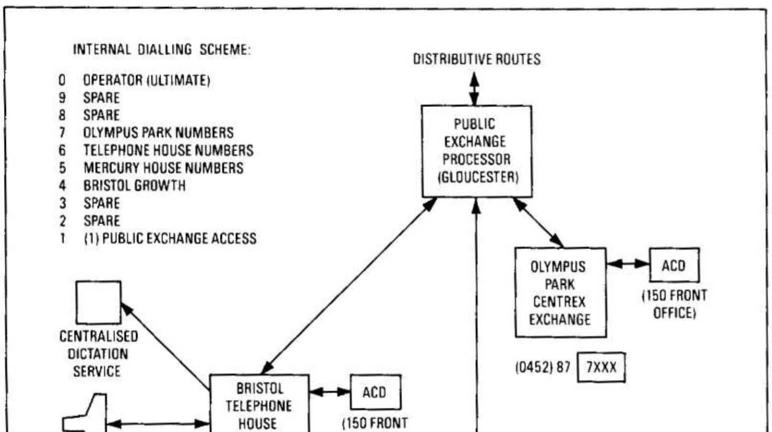
The modernisation of Severnside Districts's internal telephone system reached its second stage of development last November with the in-house introduction of Centrex services at administration offices in central Bristol. The first phase of this innovative project was completed in September 1988 with the installation of a single-site Centrex system at the District's other main office within the Olympus Park business complex near Gloucester.

Centrex is a generic term for the provision of PBX features to a customer site using digital public exchange software. Each Centrex line is the equivalent of a public exchange line with direct-dialling-in (DDI) capabilities and a range of features which emulate the facilities of a modern PBX extension. The Severnside District 'PBX' has been developed using public exchange Centrex software and AXE10 exchanges supplied by Ericsson Telecommunications Ltd.

The Severnside system (see Figure 1) now supports approximately 1500 DDI Centrex lines with full networking between offices in the north and south of the District. Internal access is provided by a linked numbering scheme; users dial the last four digits of the public exchange number to reach colleagues around the organisation. Some of the features available to a Centrex user, using a standard MF4 signalling time break recall telephone, are:

† Severnside District, BTUK

Figure 1
Severnside District PBX



- Abbreviated dialling
- Ring when free
- Conference call
- Shuttle
- Call enquiry/transfer
- Last number redial
- Call diversion (all calls/on busy/no reply)
- Hunt groups (cyclic or sequential)

The Centrex system also facilitates networking between the Ericsson supplied automatic call distribution systems (ACDs) at Gloucester and Bristol which support the larger customer-facing departments. Call transfer between customer-facing and administration functions is also possible as a result of the ACD−Centrex interconnection.

For the future, the facility will be extended to accommodate approximately 1000 additional existing service lines within the District and will ultimately support other larger sites such as the computer centre and materials warehouse. It is proposed to utilise optical fibre links between these additional sites and the exchange equipment.

Outside of some initial settling-in difficulties, the service offered to users has been very reliable. The basic features package is adequate for the majority of staff needs; operational requirements will be fully met with further software releases into 1990. Users have been pleased with the speed and effectiveness of the service after the settling-in period, albeit very minor problems still exist.

Developments eagerly awaited to further enhance the system are features such as group call pick-up and follow-me commands, and, in particular, the centralisation and replacement of the District service switchboards by purpose-built Centrex attendant consoles supported by call queueing and recall queues.

A great deal of effort has been required by District staff, supported by BT's Enhanced Network Services Group (ENS), in order to complete the second stage of this project. The active involvement of many groups to overcome obstacles, such as the creation of administration records on national systems and the handling of internal orders, has been rewarded by the availability of a District facility that is at present unique, functional and capable of significant enhancement.

The long-term objective is to reparent the two Bristol units onto a Bristol processor and provide multi-processor multi-site operation, but this must await a future release of software.

THE INSTITUTION OF BRITISH TELECOMMUNICATIONS ENGINEERS

(Founded as the Institution of Post Office Electrical Engineers in 1906)

General Secretary: Mr. J. H. Inchley, NPW9.3.1, 4th Floor, 84–89 Wood Street, London EC2V 7HL; Telephone: 01–250 9816 (071–250 9816 from 6 May 1990).
Membership and other queries should be addressed to the appropriate Local-Centre Secretary as listed on p. 267 of this issue of the *Journal*.

IBTE COUNCIL MEETING

Council held its second meeting of the 1989/90 session in Bristol, on 8 November 1989; members of Council later shared in a meeting of the Severnside Centre. The Council meeting, under the Chairmanship of Colin Shurrock, began to build on the work already undertaken to shape the future of the Institution, and was encouraged to hear of positive steps already achieved.

The President, Clive Foxell, had convened a meeting of the senior engineering managers within BT to discuss the role of the Institution. It was the unanimous view that the IBTE had a vital role to play in the education of BT engineers, and the encouragement of engineering excellence across the business. Strong and unequivocal support was expressed, and in particular a commitment to this *Journal* as a prime vehicle for dissemination of knowledge to the company's staff.

As a result of this interest, Council decided to invite Professor Eric Ash, BT Board Member, to become a Vice-President of the Institution. Further, in order to strengthen the engineering emphasis of the IBTE, Council recommended the appointment of Chris Earnshaw, Director Network, BTUK, the senior engineer within BTUK, as a Vice-Chairman of Council, and Chairman of its General Purposes and Finance Committee. Finally, as token of the invaluable part played by the Associate Section in the activities of the IBTE, and to reinforce the ties between the two sections, Council decided to recommend the appointment of the Associate Section President, Alan Bealby, as a Vice-Chairman.

Council also agreed in principle to the establishment of an Annual Congress of the IBTE, which would incorporate the Annual General Meeting, and would be held in late-May each year. The details are currently being worked through, but the intention is that the two-day Congress should recognise the Institution's achievements of the previous session, agree a strategy for the forthcoming one, and provide a focus and forum for all those involved in IBTE activities.

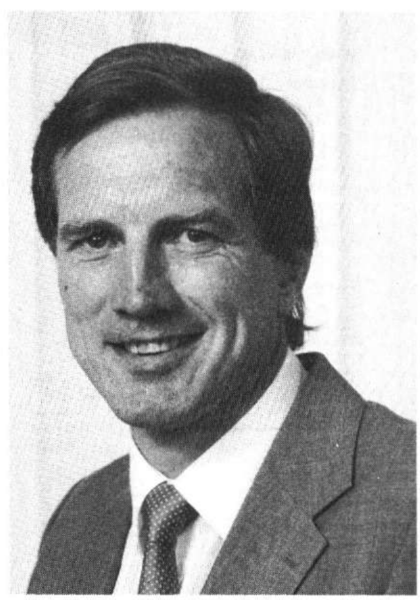
In order to assess more accurately the views and needs of the Membership and the factors which influence people to join the Institution, Council has authorised the development of a questionnaire, which will also cover attitudes to the *Journal*. The results of the questionnaire will then influence the deliberations both of Council and the Congress. However, rather than make a general distribution, it has been agreed that responses should be sought in the style of market research. Thus if you are approached to assist in this over the next few months, please spare a little time to help us. If you wish to ensure that your views are heard, then individuals may obtain copies of the questionnaire direct from the Secretary.

Finally, Council has authorised the production of replacements for the now outdated Institution tie. Two variants will be available for purchase at modest cost. Details will be published in the next issue of the *Journal*.

JON INCHLEY
General Secretary

Professor Eric Ash, new IBTE Vice-President

Chris Earnshaw, new IBTE Vice-Chairman



Alan Bealby, new IBTE Vice-Chairman

IBTE/FITCE REGIONAL SEMINARS: YORK AND MANCHESTER

A most active year in the existence of the UK FITCE group was concluded by holding the two northern seminars on 28 and 29 November 1989 in York and Manchester, respectively. The aim was to bring over some of the speakers from the 28th FITCE Congress in Lisbon to our members, as well as to give opportunities to new speakers in preparation for the Glasgow Congress in August this year. In common with previous events, three European colleagues were invited together with three speakers from British Telecom.

The speakers were Peter Hamelberg of PTT Telecommunicatie of the Netherlands, currently President of FITCE; Liam Breslin of Telecom Eireann; Gunther Altehage of Deutsche Bundespost and three BT people, Neil Runciman, Gordon Bennett and Tim Wright.

David Thomas, Chairman of the Yorkshire and Lincolnshire Centre of the IBTE opened the York meeting in Tempest Anderson Hall and welcomed the audience of IBTE Members from the two Local Centres of North East England. Peter Hamelberg gave a short talk introducing FITCE. He pointed out that, by participation in various FITCE activities, it was possible to build up a useful informal network of contacts in Europe.

Four technical papers were presented during the afternoon, starting with Neil Runciman on 'A Common Integrated Database—The Key to Improved Customer Service'. Neil coined the phrase 'the customer is king', and he went on to explain how BT is trying to keep its several million 'kings' satisfied. (An article based on Neil's paper was published in the October 1989 issue of the *Journal*.)

Gunther Altehage in his lucid style presented 'The Provision of ISDN in the DBP Telekom Network'. Gunther pointed out that the customers were not always in the right place where the network operators wanted them to be. He suggested that the network operators, through technical solutions, should take the network to the customers.

Liam Breslin's paper on 'Service 2000' hinted that the 1990s would be the decade of services, despite the technical achievements of broadband (or because of them). Liam was somewhat alarmed because of 'the gap between the significant technical investment in broadband and the unenthusiastic marketing response'.

'Planning for a Synchronous Transmission Bearer Network', presented by Gordon Bennett was the last paper of the day. Gordon mentioned the pressure being exerted by customers on their network operators to provide ever richer functionality of services, in shorter timescales, to a high level of quality. Those operators are also under pressure to keep costs and prices to a minimum. He went on to explain how the synchronous digital hierarchy would make possible the economic realisation of routing transmission capacity under software control.

BT's Tim Wright at the Manchester seminar

Peter Bailes, Secretary of the UK FITCE group, in his summing up, stressed the importance of removing the barriers in Europe.

The following afternoon's event took place in Renold Building, University of Manchester Institute of Science and Technology. John Jones, Chairman of the Manchester Centre of IBTE, welcomed the audience which included IBTE Members from Manchester and Liverpool Centres as well as Members from Birmingham. Colin Shurrock, Chairman of Council, also addressed the meeting, informing Members about the plan to hold a two-day IBTE Congress in May 1990. Colin was followed by Peter Hamelberg, Neil Runciman, Gunther Altehage and Liam Breslin in succession. The last speaker of the day was Tim Wright on 'Deployment Strategy for Transmission Networks based on the Synchronous Digital Hierarchy', which aroused considerable interest among the audience.

The success of these seminars depended on the diligent work put in by Richard Kirby and Malcolm Asquith, Secretaries respectively of Yorkshire and Lincolnshire Centre and Manchester Centre; and the support given by Director Network and Director North Territory, BTUK, and the senior managers in the Northern Districts of BTUK.

TAPASH RAY
Assistant Secretary, UK FITCE Group

IBTE LOCAL-CENTRE PROGRAMMES 1989–90

Aberdeen Centre

Meetings will be held in CCC, 9 Bridge Street, Aberdeen, commencing at 14.00 hours.

6 February 1990: *The Future of the Socket on the Wall* by F. J. DeLapeyre.

East Anglia Centre

7 February 1990: *Consideration in the Provision and Management of Private Networks and Systems for the Credit Card Industry* by R. Meggs, Manager, Telecom Support, Access. To be held at Charter Suite, Civic Centre, Victoria Avenue, Southend-on-Sea, 14.00–16.00 hours.

14 March 1990: Three short papers by Members. To be held at 3rd Floor Conference Room, St. Peter's House, Colchester, 12.30–14.30 hours. Buffet provided.

16 May 1990: *The BT Scene as viewed by AT&T & Philips* by J. Boag, AT&T & Philips Telecommunications. To be held at 3rd Floor Conference Room, St Peter's House, Colchester, 12.30–14.30 hours. Buffet lunch provided.

11 July 1990: *The Challenge of the 90s* by L. Stannage, Field Director, Central and South West England and Wales Territory. To be held at The Council Chamber, The Guildhall, Cambridge, 14.00–16.00 hours.

East Midlands Centre

All meetings will commence at 14.00 hours.

14 February 1990: *A Glimpse of the Future* by Dr. T. Rowbotham, Director Network Technology, British Telecom Research Laboratories. To be held at Nottingham University.

14 March 1990: *Optical Fibre in the Local Network* by K. Oakley, Network Systems Engineering and Technology, BTUK. To be held at Peterborough Ex-Servicemen's Club.

Liverpool Centre

21 February 1990: *Tomorrow's External Plant* by D. Clow, BTUK. Time and venue to be advised.

21 March 1990: *Whatevever Happened to the Candlestick* by Dr. I. Groves, Divisional Manager, Telephony and Data Products Division, British Telecom Research and Technology.

18 April 1990: Details to be advised.

Manchester Centre

Lectures will be held at UMIST, Manchester, commencing at 14.00 hours.

14 February 1990: *The Rise and Fall of Digital Transmission (and Switching)* by Dr. P. Cochrane, Networks Division, British Telcom Research and Technology.

14 March 1990: *Whatever Happened to the Candlestick* by Dr. I. Groves, Divisional Manager, Telephony and Data Products Division, British Telecom Research and Technology.

Martlesham Heath Centre

Meetings will be held in the John Bray Lecture Theatre, British Telecom Research Laboratories, Martlesham Heath, commencing at 16.00 hours.

14 February 1990: *The Competitive Environment* by J. C. Hibbert, DFA, British Telecom Research Laboratories. Lecture open only to BT employees; entry will be by ticket only (available from Martlesham Heath Centre Secretary).

7 March 1990: *Advances in Superconductivity* by Dr. A. Campbell, University of Cambridge.

27 March 1990: *Engineering in IAL's World of Aviation and Health Care* by A. Martin, General Manager, International Aeradio Ltd.

North Downs and Weald Centre

Meetings will be held in the Stour Centre, Ashford, 14.00–16.00 hours. Refreshments from 13.30 hours.

14 February 1990: *Total Quality Management* by IBM, Havant.

14 March 1990: *Local Loop* by R. McLachlan, BTUK.

North East Centre

6 February 1990: *Engineering in the Water Industry* (provisional title) by speaker from Northumbrian Water. To be held in Nevill Hall, Newcastle, commencing at 14.00 hours.

6 March 1990: Details to be announced.

27 March 1990: Lecture by Sir Bryan Carsberg, OFTEL. Title to be advised. To be held at the Tempest Anderson Hall, York, commencing at 13.45 hours. Joint meeting with Yorkshire and Lincolnshire Centre.

3 April 1990: *Telecommunications Cavalcade (the piper and the payer)* by R. Middleton (Manager Network Forecasting, NED). To be held in Nevill Hall, Newcastle, commencing at 14.00 hours.

North Wales and the Marches Centre

All meetings will commence at 14.00 hours.

20 February 1990: *Links Around the World* by A. J. Booth, Managing Director, British Telecom International. To be held at Whittington House, Oswestry.

6 March 1990: *Local Network Recovery Programme* by A. Ingram, Central, South West England and Wales Territory. To be held at Beauchamp Hotel, Shrewsbury.

Northern Ireland Centre

All meetings will be held at BTNI, Business Centre, Dial House, Belfast, commencing at 15.30 hours.

7 February 1990: *The Use of Computers in Maintenance* by H. Topping, and J. Porter, British Telecom Northern Ireland.

7 March 1990: *Customer Billing in the Modernised Network* by M. Kennedy, British Telecom Northern Ireland.

Severnside Centre

7 February 1990: *Electronic Messaging and Value-Added Services* by C. Jones, Dialcom Europe Ltd. To be held at Mercury House, Bristol, 14.15 hours.

8 March 1990: *Network Administration, Its Evolution Towards the 1990s* by A. Bealby, General Manager, Network Operations Support, BTUK. Joint meeting with Associate Section. To be held at Watershed, Bristol, 14.15 hours.

4 April 1990: *The President's Lecture* by A. Hurley, District General Manager, Severnside District, and Chairman, IBTE Severnside Centre. To be held at Nova House, Bristol, 14.15 hours.

South Downs Centre

Meetings will be held in the Lecture Theatre, Central Library, Richmond Road, Worthing, commencing at 12 noon.

13 February 1990: *The South East Network Operations Unit* by P. Stables (SE NOU Project Manager).

13 March 1990: *A Glimpse of the Future* by Dr. T. Rowbotham, Director, Network Technology, British Telecom Research Laboratories.

West Midlands (South) Centre

Unless otherwise stated, meetings will be held at 245 Broad Street, Birmingham.

14 February 1990: *BT Fulcrum The Way Ahead* by T. Brassil, BT Fulcrum. Commencing at 14.00 hours.

14 March 1990: *What Now—Legionella* by Dr. P. Williams, Nalfloc Ltd., Northwich, Cheshire. Commencing at 14.00 hours.

11 April 1990: *NICAM-728 TV Stereo Broadcasting* by B. Rhodes, Head of Engineering Information, IBA, Crawley Court, Winchester. Commencing at 14.00 hours.

9 May 1990: *Telecommunication Services in the 1990s* by Duncan Lewis, Director Procurement, Strategy and Network Services, BTUK. Joint IBTE/IEE meeting. To be held at Queen Elizabeth Medical Centre, Birmingham, commencing at 18.30 hours.

West Midlands (North) Centre

19 February 1990: *A Study of Office Automation in Sweden* by D. Podmore, Computer Sector, BT Fulcrum. Meeting will be held at British Telecom Technical College, Stone, commencing at 13.45 hours.

Westward Centre

1 February 1990: *Glimpse of the Future* by Dr. T. Rowbotham, Director Network Technology, British Telecom Research Laboratories. To be held in Lecture Theatre F, Newman Building, Exeter University.

Yorkshire and Lincolnshire Centre

14 February 1990: *East Coast Main Line Electrification* by C. N. Schofield, British Rail (Eastern) Project Manager, ECML (Electrification). To be held at the Tempest Anderson Hall, York, commencing at 13.45 hours.

27 March 1990: *OFTEL* by Sir Bryan Carsberg, Director-General, OFTEL. To be held at the Tempest Anderson Hall, York, commencing at 13.45 hours. Joint meeting with North East Centre.

RETIRED MEMBERS

Members about to retire can secure life membership of the Institution at a once-and-for-all cost of £10·00 and so continue to enjoy the facilities provided, including a free copy of the *Journal*. Enquires should be directed to the appropriate Local-Centre Secretary.

NOTIFICATION OF CHANGES OF ADDRESS

IBTE Members and *Journal* subscribers who change their home address should ensure that they notify the *Journal* office on the address-label slip provided with every copy of the *Journal*.

All enquiries related to distribution of the *Journal* should be directed to The IBTE Administration Manager, 3rd Floor, 84–89 Wood Street, London EC2V 7HL. Telephone: 01–356 8050 (071–356 8050 from 6 May 1990).

LOCAL-CENTRE SECRETARIES

The following is a list of Local-Centre Secretaries, to whom enquiries about the Institution should be addressed.

Centre	*Local Secretary*	*Address and Telephone Number*
Aberdeen	Mr. A. T. Mutch	British Telecom, D2.2.4, New Telecom House, 73–77 College Street, Aberdeen AB9 1AR. Tel: (0224) 753343.
East Anglia	Mr. T. W. Birdseye	East Anglia District NL1.5.12, Telephone House, 45 Victoria Avenue, Southend-on-Sea, Essex SS2 6BA. Tel: (0702) 373106.
East Midlands	Mr. D. H. Bostrom	IO4, 200 Charles Street, Leicester LE1 1BA. Tel: (0533) 534212
East of Scotland	Enquiries to: Mr. B. Currie	British Telecom East of Scotland District, NJ3, Telephone House, 357 Gorgie Road, Edinburgh EH11 2RP. Tel: 031–345 4218.
Lancs and Cumbria	Mr. A. J. Oxley	SM4, BMC, North Street, Preston PR1 1BA. Tel: 0772 265419.
Liverpool	Mr. B. Stewart	British Telecom Liverpool District, CS63, Room 413, Lancaster House, Old Hall Street, Liverpool L3 9PY. Tel: 051–229 4444.
London	Mr. C. J. Webb	British Telecom, LSO/PA1.3.2, Room 202c, Camelford House, 87 Albert Embankment, London SE1 7TS. Tel: 01–587 8258.
Manchester	Mr. J. M. Asquith	British Telecom, NE20, Telecom House, 91 London Road, Manchester M60 1HQ. Tel: 061–600 5171.
Martlesham Heath	Mr. M. Shaw	RT5241, MLB/3/50, British Telecom Research Laboratories, Martlesham Heath, Ipswich IP5 7RE. Tel: (0473) 645594.
North Downs and Weald	Mr. N. Smith	British Telecom, NP4, Telephone House, Rheims Way, Canterbury, Kent CT1 3BA. Tel: (0227) 474594.
North East	Mr. P. L. Barrett	British Telecom North East, EP38, Swan House, 157 Pilgrim Street, Newcastle-upon-Tyne NE1 1BA. Tel: 091–261 3178.
North Wales and the Marches	Mr. P. C. Clay	N4.4.3, Communication House, Harlescott Lane, Shrewsbury SY1 3AQ. Tel: (0743) 274353.
Northern Ireland	Mr. D. S. Elliott	ND26, Churchill House, 20 Victoria Square, Belfast BT1 4BA. Tel: (0232) 240353.
Severnside	Mr. I. Davies	EP58, Telephone House, Queen Charlotte Street, Bristol BS1 1BA. Tel: (0272) 206701.
Solent	Mr. D. Henshall	BE33, Solent District Office, 70–75 High Street, Southampton SO9 1BB. Tel: (0703) 823421.
South Downs	Mr. C. J. Mayhew	British Telecom South Downs District Office, ED8, Grenville House, 52 Churchill Square, Brighton, BN1 2ER. Tel: (0273) 225030.
South Midlands	Mr. J. Coley	British Telcom, LL115, Telecom House, 25–27 St. Johns Street, Bedford MK42 0BA. Tel: (0234) 274849.
South Wales	Mr. P. F. Coleman	WP6, British Telecom South Wales, District Engineering Office, 25 Pendywallt Road, Coryton, Cardiff. Tel: (0222) 691622.
Thameswey	Mr. R. D. Hooker	Thameswey District Head Office, DE4.7, Telecom House, 49 Friar Street, Reading, Berkshire RG1 1BA. Tel: (0734) 501754.
West Midlands (North)	Mr. R. J. Piper	c/o Mr. M. N. B. Thompson, BT Technical College, Stone, Staffordshire ST15 0NL. Tel: (0785) 813483.
West Midlands (South)	Mr. G. R. Chattaway	British Telecom, WMD/EME24, Telecom Centre, Little Park Street, Coventry CV1 2JY. Tel: (0203) 228396.
West of Scotland	Mr. L. M. Shand	TNO/S1.3.6, Dial House, Bishop Street, Glasgow G3 8UE. Tel: 041–221 1585.
Westward	Mr. R. Rand	British Telecom, NP2, Exbridge House, Commercial Road, Exeter EX2 4BB. Tel: (0392) 212681.
Yorkshire and Lincolnshire	Mr. R. S. Kirby	BTUK/North/NO3, Netel House, 6 Grace Street, Leeds LS1 1EA. Tel: (0532) 466366.

British Telecom Press Notices

Tymnet Purchase Completed

In November last year, British Telecom completed the purchase of the Tymnet network systems business and its associated applications activities from the McDonnell Douglas Corporation for the agreed sum of $355M.

The world-wide network systems and network applications business is now being run by a new wholly-owned BT subsidiary—BT Tymnet Inc, a US registered company with its headquarters in San José. Its activities comprise:

- TYMNET, the public network business, together with its associated private and hybrid (mixed public and private) network activities;
- the OnTyme electronic mail service;
- the Card Service processing business; and
- the EDI*Net electronic data interchange system.

Tymnet, an international value-added network provider, is one of the world's largest suppliers of shared, dedicated and hybrid network services.

The TYMNET network is accessible from over 850 cities in the United States and provides communications links to over 100 countries. Many of the world-wide network connections are supported directly or via the local telecommunications administrations (PTTs), while others are established via gateways to international networks using packet-switching standards. EDI*Net is the US market leader in electronic data interchange (EDI).

Commenting, BT's Chairman, Iain Vallance, said: 'Tymnet has a good name round the world; it has a long-established reputation for meeting customers' needs. British Telecom intends to uphold and build on that fine record.

'Together with the activities of our other US subsidiaries, we now have a major foothold in the US network services and value-added market-place. We also have good market access in many advanced countries, an improved presence in Japan and a valuable position in many other countries. This is a sound basis on which to build strong international customer services.'

Mark Baker, President and chief executive officer of BT Tymnet, emphasised the customer benefits that would flow from the purchase. He said: 'For the immediate future, while the management team creates a cohesive global company from the variety of activities we have acquired, it will be business as usual.

'But increasingly we will be able to deliver and, if required, operate for our multi-national customers a reliable managed network service end-to-end. We shall also be developing dedicated or hybrid networks that embrace the world's major trading areas.

'Our customers will soon be able to enjoy:

- one-stop shopping for their global data networks;
- a well-structured global portfolio of services based on an integrated hierarchy of standards and protocols;
- a co-ordinated portfolio of products designed for a global market-place; and
- support by a global organisational structure designed to recognise and respond quickly to their needs.'

British Telecom Marine Orders New-Generation Cable Ship

BT Marine, British Telecom's undersea cable laying subsidiary, is to build its first new cable ship since the 1970s.

A contract for more than £30M has been awarded to Van der Giessen de Noord of Holland. This follows negotiations lasting several months and intense international competition.

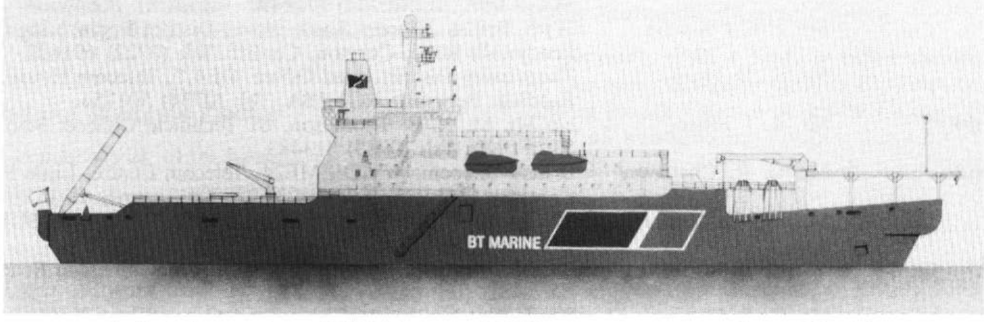
The new 12 500 tonne vessel is a joint design and concept of BT (Marine) Limited, Hart Fenton Limited (consulting naval architects) and Van Der Giessen de Noord. This is a unique and innovative design reflecting the increased sophistication of the international cable industry and advances in optical-fibre technology.

The cable ship will be deployed primarily on the maintenance of transatlantic submarine communications cables, replacing the company's *CS Alert* which currently operates within the Atlantic Cable Maintenance Agreement.

With a hull form designed to provide enhanced sea-keeping qualities, powerful manoeuvring thrusters and the capacity to store nearly 2200 nautical miles of deep sea telecommunications cable, she will be able to tackle a wide range of projects in all water depths.

The ship's design provides an A-frame over large clear decks to enable many forms of submersible craft to be operated, including cable repair submersibles and cable-burying ploughs.

She is expected to come into service in October 1991 and will operate from BT Marine's main base in Southampton.



Artist's impression of BT Marine's 12 500 tonne new-generation cable ship

Singapore Telecom Awards BT £13M Contract for Customer Service System

British Telecom's unique computer system already improving service for customers in the UK is to be adopted in the Far East in a 40·2 million singapore dollars (approximately £13M) deal won against fierce competition from both North America and Japan. BT's Customer Service System (CSS) software will form a major part of an advanced computerised customer and service information system to be installed by Singapore Telecom.

CSS is a fully integrated screen-based information system which enables operators to deal with order, billing and fault enquiries while the customer is still on the line. Ultimately, customers will deal with just one unit for the majority of their telecommunications needs, dramatically improving response time and quality of service.

This major export success comes just two years after BT introduced CSS into its own network. The new system will serve about a million customers in Singapore. Singapore is one of the world's most technologically advanced telecommunications centres, representing a strategically important market for global telecomunnications companies. Singapore Telecom's system will be phased in within a 2 year period. The project team will comprise 200 personnel from BT, Singapore Telecom and some Singaporean software houses. BT has also signed a Memorandum of Understanding with Singapore Telecom for further co-operation.

Launch of the Digital Communications Era

Plans for the digital communications era of the future—paving the way for the even more highly technological applications—such as the picture phone, ultra-fast fax and high-speed data transfer—have been unveiled by British Telecom. BT is launching a new advanced service to carry voice, data and pictures, called *British Telecom ISDN 2*.

It will provide high-speed digital services to branch offices of large companies as well as to small and medium businesses. Such services have until now been available only to large business sites.

The launch of ISDN 2 follows a £23M order with STC Telecommunications for equipment to provide up to 90 000 lines of network capacity. This is equivalent to 180 000 ordinary telephone connections.

Announcing the new service, Mr. Nick Kane, BT's Director of Marketing and Sales said: 'This important new service allows British Telecom's public network to meet our customers' communication needs for data, text, fax, graphics and video, as well as voice, over a single high-speed digital connection. ISDN 2 will combine the power of advanced private networks with the simplicity and universality of the ordinary telephone.'

British Telecom ISDN 2 will provide customers with two high-speed digital exchange connections on one pair of wires. They will be able to exchange calls with users of British Telecom's ISDN service—Multiline IDA—which already provides links to digital office switchboards, as well as to customers on the current telephone network.

The launch of ISDN 2 provides British Telecom with a total ISDN product range for large and small sites, offering customers a total ISDN solution to their communications needs.

Mr. Kane commented: 'Our customers with large office networks will now be able to establish switched digital connections for voice and data between their main digital integrated-services PBXs and their local branches. The service will also allow private networks to be linked more easily to British Telecom's public system.

'Our new service—the first ISDN service in the world to conform to the latest international standards now being adopted world-wide—could become, by the mid-1990s, the standard exchange line service for all customers who want two or more connections. It enables a broad spectrum of our customers to take advantage of information technology services previously available only to large businesses. In so doing it will accelerate the introduction of the information society.'

Customers will use ISDN 2 to make national and international telephone calls in the ordinary way, and at the same cost. In addition, they will be able to make data, video and other digital services calls within the UK, and to France, USA and Japan. More international links are planned.

ISDN 2 will offer many additional benefits over those of existing services, including:

- even better quality basic telephone service, with faster call set-up, clearer speech, and fewer data transmission errors;
- greater flexibility and efficiency, allowing customers to use their lines for data or speech at will;
- lower-cost data calls because of higher-speed operation;
- identification of callers on incoming calls and of called lines on outgoing calls, on digital end-to-end connections;
- setting up of wide-area quasi-private networks over the public network;
- support for true integrated-services workstations combining voice and data to achieve improved communications; and
- longer-term lower cost for ordinary telephone connections because ISDN 2 should eventually prove cheaper than two separate lines.

The new service, after starting as a test market, is due to be rolled out as a public commercial service from the end of April this year. The initial network capacity of up to 90 000 digital connections will be rolled out over 18 months. This will enable BT to offer an ISDN 2 service from all its System X digital exchanges—currently totalling more than 2000—by the end of 1991. This will cover all business centres and recognised high streets in the UK. Service will also be made available on BT's AXE10 exchanges.

BT has been working with industry to encourage development of terminals which customers can connect to ISDN 2. They are expected to be available shortly from a number of suppliers. Initially, these are likely to be the normal industry-standard personal computers found in offices today, but equipped with ISDN communications cards for data/voice conferencing, file transfer and distributed processing. They will still be able to perform word processing and other office IT applications, as well as operating as ISDN terminals. Later, integrated key systems and small PBXs are expected to be introduced.

ISDN 2 will be able to carry many of the applications now being run on private long-distance networks and local area networks. These could include EPOS (electronic data transfer at the point of sale), mortgage and insurance quotations, and retrieval of the financial and commercial data many businesses use for their day-to-day activities.

In the next few years, even more imaginative applications should appear, such as viewphone, high-speed fax, and the transfer of coloured maps and diagrams originating from optical disc stores. Such applications would be especially useful to small-to-medium businesses and branch offices, such as estate agents, advertising agents, designers, and other graphics-arts companies, publishers, and consumer-goods suppliers.

Product News

British Telecom Announces O.S.C.A. and T-NET Enhancements

BT's commitment to offering its customers the most advanced networking systems and solutions available is highlighted by the announcement of a new series of voice and data product enhancements for its successful open systems cabling architecture (O.S.C.A.) structured wiring and T-NET local area network (LAN) portfolios.

O.S.C.A. is an extremely-flexible easily-managed vendor-independent wiring scheme for both voice and data communications. O.S.C.A. supports the majority of computer systems on the market, including IBM 3270, AS400 and IBM System 3x, Wang and V.24 synchronous and asynchronous.

Among the new enhancements is support for the RJ45 data connector, which is now added to the O.S.C.A. portfolio. It is a result of BT's extensive design and investment programme implemented after detailed research and discussions with customers. British Telecom's support for RJ45—an eight wire socket—will enable those customers using O.S.C.A. and T-NET to receive the full benefits of BT's integrated services digital network (ISDN).

In addition, to meet long-term communications requirements, BT has developed a consolidated product that offers customers dual voice and data function over O.S.C.A. at the socket faceplate and wiring closet. BT has also upgraded its O.S.C.A. equipment racks, used for mounting cabling accessories. The rack's new modular design will provide users with an easily reconfigurable and expandable system.

The T-NET LAN portfolio offers customers a comprehensive range of communications options and supports both general purpose and PC networking. The extensive communications facilities provide connectivity to corporate information resources (for example, mainframes, minicomputers), messaging into external systems (for example, fax, Telex, e-mail) and links to other sites.

As part of the continual enhancement programme for its T-NET LAN portfolio, BT has also launched extra expansion cards for its twisted pair access cabinet (T-PAC)—the physical link between O.S.C.A. and T-NET—to provide complete systems management and control. Computer systems from the majority of vendors can be linked to O.S.C.A. and T-NET via the T-PAC unit allowing customers to combine the power of a LAN with the flexibility of structured cabling.

The T-PAC cabinet is housed in a wiring closet, and provides Ethernet, token ring, asynchronous and 3270 connectivity to network stations over O.S.C.A.'s unshielded twisted pair wiring. Utilising the O.S.C.A. T-PAC, BT can provide customers with a fully integrated cabling and LAN system.

This innovative combination of network services and structured wiring systems allows for various workstations and terminals to be combined within the same communications infrastructure. This will give customers increased power, unrivalled systems flexibility and greater access to multi-vendor environments within the office, nationally and internationally.

New Pagers for Business

British Telecom Mobile Communications' new range of distinctive and innovative pagers—the Series 1200—incorporate a high degree of functionality and user friendliness.

Flagships of this new series are two new alphanumeric Message Masters. Both models have an extensive memory, being able to receive and store up to 15 words each. Memory map display and scroll facility for a quick search of messages in the memory are also features.

An increasingly popular feature, which is available on several models, is a vibrating facility. This is ideal for use in meetings where a paging bleep or light is unacceptable. It is also finding use by the deaf.

The belt clip Message Master now has a large easy-read sloping display which enables it to be read whist attached to the belt.

The Series 1200 numeric pager can receive messages up to 20 numbers in length. It is ideal for those who need to receive telephone numbers, times, dates, prices or coded data of all kinds. Two tone alerts are avilable for key contacts and the silent vibration facility can be provided.

Tone-only pagers continue to retain their popularity and the 1200 Tone Page is ideally suited for this market sector. Simple and very economic, the Tone Page has four distinctive tones for important callers and can also be provided with a silent vibration facility.

Series 1200 radiopagers

British Telecom's New Dealerboard Voice Switch

BT has launched the dsX dealerboard voice switch, a highly featured communications solution designed to provide financial traders with the most advanced telephony switch technology available.

Created specifically for large banks and dealing houses with massive communications requirements, the dsX can accommodate up to 6000 lines and over 2000 trading positions. The dsX supports BT's entire integrated trading systems (ITS) portfolio, giving users of ITS screen or key-based dealerboards a system which removes all barriers to dealing room communications.

The dsX utilises the latest digital technology to ensure that traders have fast, clear and reliable contact with their customers. A sub-100 ms connection time provides dealers with a competitive advantage no other switch in the market can offer.

Greater resilience is achieved by a fully duplicated architecture enabling traders to access any line in the network in the event of component failure. Enhanced system management via the Genidad management package gives communications managers the ability to change line functions and console facilities to take account of new circumstances.

Also, as many large traders occupy expensive City properties, the compact dsX enables them to make the most cost-effective use of their often limited space. Additionally, the easily installed dsX helps eliminate the disruption and cost incurred during office reconfiguration.

British Telecom Expands Range of Desktop Personal Computers

British Telecom has announced the launch of two new ranges of 80386-based IBM-AT compatible desktop personal computers, the M5330/25 and M5320-SX. Designed as powerful and expandable workhorses, both models offer ultra-high-speed data processing by using 80386 and 80386-SX processors running at 25 MHz (M5330/25) and 16 MHz (M5320-SX), respectively.

The M5330/25 range comprises the M5336/25 with a 150 Mbyte hard disc and the M5337/25 with a 300 Mbyte hard disc. Both have a 1·44 Mbyte 3·5 inch floppy disc drive.

The M5320-SX range includes the M5324-SX with a 40 Mbyte disc and the 100 Mbyte M5325-SX. Like the M5330/25 series, both have a 1·44 Mbyte 3·5 inch floppy disk drive.

The M5330/25 range has a standard memory of 2 Mbyte which can be expanded up to 8 Mbyte on-board by using 1 Mbyte single in-line memory modules (SIMM). 4 Mbyte SIMM packs soon to be introduced will enable the memory to be expanded to 32 Mbyte on-board. A total of seven expansion slots are available.

The M5320-SX range offers 1 Mbyte standard memory which can also be expanded up to 8 Mbyte on-board using 1 Mbyte SIMM packs. Five expansion slots are provided with these machines.

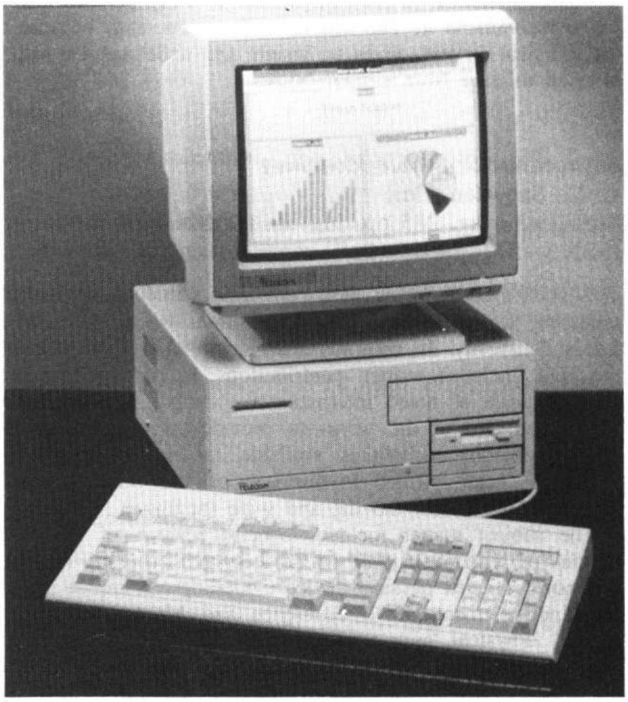
Both ranges are supplied with the current industry-standard 31 kHz video graphics array (VGA) capability. A 102-key keyboard ensures ergonomic efficiency by incorporating 12 function keys and a 30 key repeat function solves the problem of long cursor runs on spreadsheets and reports.

Also available is an optional asynchronous communications package using an advanced internal modem, which gives access via the telephone network to Prestel, Telecom Gold and other dial-up services.

Both the M5330/25 and M5320-SX computers use a fast memory caching technique. A cache memory of 64 kbyte is offered as standard in the 25 Mhz system, and the 386-SX machines provide 4 kbyte cache. The efficiency and speed of the processors in both series are further enhanced by up to 10% through the use of *slushware*. This is achieved by porting the basic input output system (BIOS), which is normally held in slow-access read-only memory (ROM), into dynamic random-access memory (DRAM).

The unique styling of these machines allows BT's range of Lektor PC security products to be easily incorporated if required. Both machines support OS/2 and DOS, offer total systems flexibility and are ideal file servers on local area networks.

M5330/25



M5320-SX

Book Reviews

Analogue and Digital Signal Processing and Coding
P. M. Grant, C. F. N. Cowan, B. Mulgrew, and J. H. Dripps.
Chartwell-Bratt. 366 pp. £11·95.
ISBN 0−86238−206−8.

The book has been compiled from the lecture notes of an industrial course run by staff of the Electrical Engineering Department of the University of Edinburgh. The text provides a general introduction and overview of both analogue and digital signal processing, and coding, concentrating on practical aspects which relate to communication applications. Overall, there is a slight bias in content towards digital methods, but that is to be expected with the variety of techniques and applications supported by that discipline.

The text is aimed at graduate level students with some background in signal theory appropriate to engineering electronics. Containing twenty chapters in total, a wide range of topics are covered by the book, which gives a good overview but limits the depth of coverage of each subject area. Tutorial sections (but no solutions) are given at the end of most of the chapters.

With regard to content, fundamentals such as Laplace and z-transforms, Fourier transforms, frequency and time-domain analysis, data conversion and aliasing are covered in the early chapters. A large section of the book is concerned with fixed and adaptive filter design. Frequency-domain techniques for continuous analogue and digital filters (both finite and infinite impulse response varieties) are considered. One chapter looks at analogue sampled data processing and filter implementations. For design of optimal time-domain estimators, Wiener, Kalman and adaptive filtering techniques are discussed.

Another section of the book is concerned with spectral estimation, dealing with discrete and fast Fourier transform theory and hardware implementation, and modern spectral analysis techniques including autoregressive modelling. On the application side, block and convolution codes for error detection and correction, speech coding, image processing, and nonlinear filtering techniques such as median filtering are considered. A case study looks at coding and matched filters for radar and communications.

As an introduction to, and overview of, signal processing and its applications in the communication area, the book has a lot to recommend it. The text is well written, and, because of the practical content, gives an insight and understanding which is often missing from similar books.

M. C. Hall

Semiconductor Device Modelling
C. M. Snowden (Ed.)
Springer-Verlag. 285 pp. 111 ills. DM85·00.
ISBN 3−540−19545−9.

This book grew out of a short course on semiconductor device modelling techniques and their applications which was held at Leeds University. In common with many such short courses, the book includes written contributions on particular aspects from a range of noted international scientists and engineers. The stated aim of the work—to provide an insight into the many modelling techniques available for semiconductor devices—has been fulfilled in this one volume which covers a subject which is fast moving and wide ranging.

The subject matter includes concise reviews of the basic physics of semiconductors and devices, and covers a range of the more complex physical device modelling techniques including finite element, finite difference and Monte Carlo techniques. Physical and equivalent circuit models and their application at high frequencies and in VLSI are also discussed. Of topical interest are sections on the modelling of semiconductor lasers, and quantum devices.

The book will be of interest to readers who have a wide range of backgrounds and experience. For the informed reader, the book is a concise source of information on a broad range of modelling techniques, and a useful source of references for further reading. For the novice, it offers a good overview, and, starting from device physics and working through to VLSI modelling, will enable the reader to gain a good general appreciation of the different techniques which are most commonly used in modelling.

I. Henning

Adaptive Detectors for Digital Modems
A. P. Clark.
John Wiley & Sons Ltd. 459 pp. 161 ills. £44·00.
ISBN 0−7273−0112−8.

The book is concerned with techniques for achieving near optimum performance for data transmission over bandlimited channels, where both linear distortion and additive white Gaussian noise are present. It concentrates mainly on detection and estimation techniques, where the latter may be adaptively adjusted at the receiver. The book is a companion volume to *Equalizers for Digital Modems* by the same author, and starts where the other book finishes.

To set the scene, chapter one opens with the assumed model for data transmission, and includes a section on the application of this model to practical line and radio channels. There then follows a chapter on maximum likelihood detection techniques, with particular reference to implementations based on the Viterbi algorithm. Separate chapters are then devoted to near maximum-likelihood detection techniques for real-valued basedband signals, and to detection techniques for speech-band telephone circuits, and time-varying HF radio links. Two chapters are devoted to the subject of channel estimation, with particular reference to their application to time-varying HF and land mobile radio systems. The author has endeavoured to make each of the chapters as self-contained as possible, and provides a comprehensive list of references arranged chronologically with each chapter to aid the reader with further study.

The book is useful to data transmission designers, in that it brings together in a coherent whole many of the important results of the study of adaptive detectors. It provides useful guidelines on how to apply the theoretically optimum techniques to more practical sub-optimum systems. The book is well endowed with computer simulation results, much of which is based on research at Loughborough University. No computer simulation, no matter how extensive, can completely describe all the complex interactions that occur in a modern adaptive high-speed modem. However, the author has made great efforts to ensure the validity of the computer simulation results obtained, and has used them to good effect to demonstrate the inherent advantages of the various sub-optimum schemes. Of particular relevance is the theme running throughout the book that performance close to that of the optimum system can be obtained for a small proportion of the processing power or complexity. This aspect is of growing importance especially in the more mature area of speech-band telephone modems, where cost and complexity are crucial to the commercial viability of a modem design.

I occasionally found it difficult to keep track of all the systems being analysed, many of which were cryptically referred to by single letters or numerals. This is a minor point—overall the book encapsulates the results of many years of excellent research effort on the complex subject of sub-optimum adaptive processes for modems, and is to be recommended to any serious student or practitioner of data transmission modem design.

F. A. Westall

Notes and Comments

CONTRIBUTIONS TO THE JOURNAL

Contributions of articles to *British Telecommunications Engineering* are always welcome. Anyone who feels that he or she could contribute an article (either short or long) of technical, managerial or general interest to engineers in British Telecom and the Post Office is invited to contact the editors at the address given below. The editors will always be pleased to give advice and try to arrange for help with the preparation of an article if needed.

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Forthcoming Conferences

Further details can be obtained from the conferences department of the organising body.

Institution of Electrical Engineers, Savoy Place, London WC2R 0BL. Telephone: 01–240 1871.

UK IT 1990. 19–22 March 1990. University of Southampton.

Automated Test and Diagnosis. 9–12 April 1990. International Conference Centre, Bournemouth.

International Switching Symposium. 27 May–1 June 1990. Stockholm. Details from: ISS 90, Congrex Sweden AB, PO Box 5619, S-11486 Stockholm, Sweden.

Advanced Infrared Detectors and Systems. 5–7 June 1990. IEE, London.

Expert Planning Systems. 27–29 June 1990. Metropole Hotel, Brighton.

Radio Receivers and Associated Systems. 23–27 July 1990. Churchill College, Cambridge.

Electromagnetic Compatibility. 28–31 August 1990. University of York.

Integrated Broadband Services and Networks. 15–18 October 1990. IEE, London.

Rural Telecommunications. 29–31 October 1990. IEE, London.

Information Technology and People. 29–31 October 1990. International Conference Centre, Bournemouth.

Control 91. 25–28 March 1991. Edinburgh Conference Centre, Heriot-Watt University, Edinburgh. *Call for Papers*: Synopses by 1 August 1990.

Antennas and Propagation, 14–18 April 1991. University of York.

Vacation Schools:

Digital Signal Processing Devices and Applications. 18–23 March 1990. University of Leicester.

Network Technology. 25–30 March 1990. University of Wales, Swansea.

Software Engineering for Electronic System Designers. 1–6 April 1990. University of Warwick.

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The selected authors will be given the opportunity to present the same papers to an international audience at the 29th European Telecommunications Congress to be held at Glasgow in August 1990.

For further information, please contact Tapash Ray, Assistant Secretary FITCE, BTUK/NPW8.1.3, 2C75, The Angel Centre, 403 St John Street, London EC1V 4PL. Telephone: 01–239 0429. Fax: 01–239 0426.

READING AND GLASGOW SEMINARS

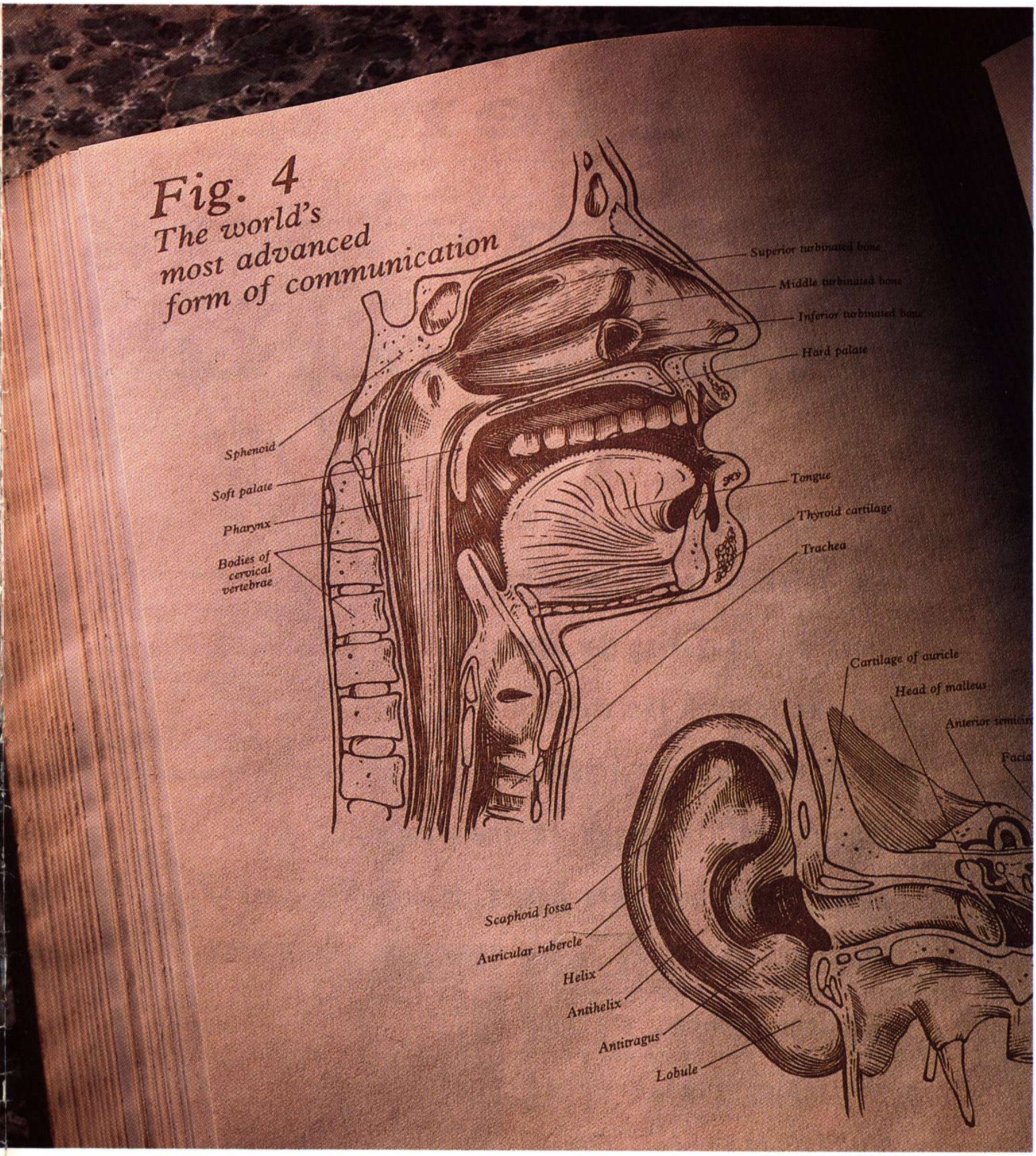
The FITCE Group of IBTE in conjunction with the IBTE Thamswey Centre and IBTE West of Scotland Centre is organising two half-day Regional Seminars which are due to be held on Friday 23 February 1990 at Ramada Hotel, Reading, and then on Friday 9 March 1990 at Mitchell Theatre, Grenville Street, Glasgow. Both seminars will commence at 14.00 hours and end at 17.00 hours. All IBTE members are cordially invited to attend.

It is expected that invited speakers from continental Europe will attend the seminars and present technical papers. IBTE members interested in presenting papers should note 'Call for Papers' above.

For further information on these seminars, please contact:

Mr. Robert Hooker, Secretary, IBTE Thameswey Centre, BT Thamswey District, DE47, Telecom House, 49 Friar Street, Reading RG1 1BA. Tel: 0734 501754. Fax: 0734 503482.

Mr. Lewis Shand, Secretary, IBTE West of Scotland Centre, BT West of Scotland District, TNO/S136, Dial House, Bishop Street, Glasgow G3 8UE. Tel: 041–221 1585. Fax: 041–221 1590.



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